Joint Strategic Needs Assessment: Outdoor Air Quality in Kingston

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Contents

Summary

Poor air quality is having a significant impact on the health of people who live, work, study and spend time in Kingston, contributing to the equivalent of one in twenty deaths for people who live in the area. It has been linked to strokes, heart disease, asthma and Chronic Obstructive Pulmonary Disease (COPD) and it particularly affects vulnerable people, including children, older people, those with health problems and those who live in deprived communities.

Over the long term, Kingston's air quality has improved, and is expected to reach key EU air quality targets by 2020. However, there are some pollutants for which no safe level of exposure has been found, and almost all parts of the borough have worse air quality than the average for England. This means air quality remains an important public health issue for Kingston and for other parts of Greater London.

Although harmful outdoor air pollution comes from many places, the biggest source of it in Kingston is road traffic. Air pollution is most concentrated in parts of Kingston where there is high traffic congestion, so successfully reducing emissions from traffic would be the most impactful thing to do to reduce the harm that pollution causes to the health of local people.

Kingston Council is already working to improve air quality through its Air Quality Action Plan, and there are opportunities to go further by making it easy for more people to walk, cycle and use public transport for local journeys and by making sure planning rules consider the air quality impact of new developments.

Local business and public services all have a part to play too. Schools, colleges, hospitals and healthcare facilities, and employers all contribute to congestion and transport emissions, and can all help to reduce their impact on both the local environment and on people's health.

This JSNA chapter makes recommendations for all these organisations and for local residents and visitors about how to minimise the health impact of outdoor air pollution.

1. Introduction

Air pollution is a major public health issue, causing an estimated three million deaths a year around the world.[1] [2]

Although air quality in western Europe is better than in many lower and middle-income countries, pollution is the single biggest environmental contributor to ill-health in the UK and around the world.[3] Reducing pollution is a priority for national, regional and local government following high profile breaches of European limits for some of the most common pollutants.

London has been a focal point for public health action on air quality since the Clean Air Act of 1956, which followed a reported 4,000 deaths during the Great Smog.[4] The Clean Air Act brought about dramatic reductions in coal burning and visible pollution, and as a result we now face very different challenges in how to improve the quality of the air we breathe, with most air pollution now coming from road traffic.

Kingston's air is generally healthier than that of some other parts of London, but the people who live, work, study or visit the borough can still be exposed to levels of pollution that are harmful to their health, particularly close to busy, congested roads.

[1] Kelly and Fussell, Air pollution and public health: emerging hazards and improved understanding of risk, Environmental Geochemistry and Health August 2015, Volume 37, Issue 4, pp 631–649 https://link.springer.com/article/10.1007/s10653-015-9720-1

[2] http://www.who.int/gho/phe/outdoor_air_pollution/burden_text/en/ (accessed January 2018)

[3] Global Burden of Disease, 2015, see http://www.thelancet.com/lancet/visualisations/gbd-compare (accessed February 2018)

[4] BBC, Great Smog 60 Years On, 2012 http://www.bbc.co.uk/news/uk-england-london-20269309 (accessed January 2018)

2. Scope of this document

This document has been prepared by Kingston Public Health. It forms a chapter of the Kingston Joint Strategic Needs Assessment (JSNA), which the Health and Wellbeing Board has a statutory duty to prepare in order to inform the Joint Health and Wellbeing Strategy.

This JSNA chapter reviews current evidence about outdoor air quality in Kingston and makes recommendations about what can be done to reduce its negative impact on public health. It brings this evidence together with information about the priorities of local people and the plans of Kingston Council and other local organisations.

By combining these sources of information, we can:

- Identify what can be done about air quality to make the most difference to public health in Kingston
- Identify and build on the strengths of our existing local approach to improving air quality
- Make the case for more local action where it is needed

It is intended to be useful to the following groups of people, and makes a series of recommendations for each of them:

- The Greater London Authority
- Kingston Council's Parking, Highways and Transport, Planning, Public Health and Environmental Health teams
- Healthcare commissioners and providers
- Developers
- Kingston residents
- Local businesses and other employers
- Local schools, colleges and universities

This document is specifically focused on outdoor air quality, its public health effects in Kingston and how to mitigate these effects locally. It does not give systematic consideration to indoor air quality or to other environmental determinants of health such as noise pollution or climate change. Although it also reviews some aspects of the wider context, it also does not make recommendations about what action is required to reduce the public health impact of air pollution at national or international level.

Nevertheless, an estimated 40-55% of particulate air pollution in London comes from outside the area.[5] This means that a comprehensive approach to air quality improvements needs international, national and regional action as well as local plans, and it is important that work to protect people's health from the effects of air pollution continues at all these levels.

[5] GLA, Air Quality in Kingston upon Thames: A guide for Public Health Professionals (accessed January 2018)

3. What is air pollution and where does it come from?

"Air pollution" refers to any chemical, physical, or biological agent that changes the natural characteristics of the atmosphere[6]. The air pollutants that are most relevant to health in Kingston are particulate matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_x), sulphur dioxide ($S0_2$) and ozone (O_3).

Particulate matter is a mixture of tiny particles made up of different chemicals. It's categorised by the size of the particles rather than by what they are made from. PM_{10} means particles that are less than 10 microns across, while $PM_{2.5}$ means particles less than 2.5 microns across (see figure 1).[7] The smaller the particle, the easier it is for it to get deep into the lungs, so the smaller particles are ones most likely to impact public health.

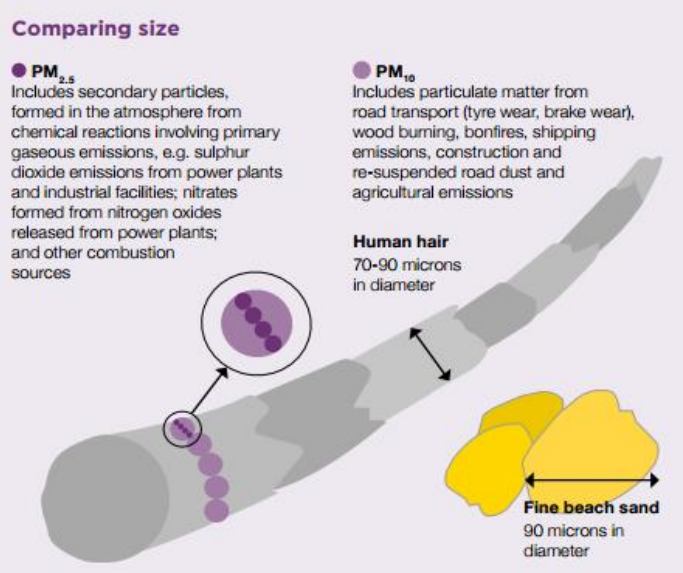


Figure 1: size of particulates (source: reference 7)

Oxides of nitrogen (NO_x) are gases which are produced when fuels are burned at high temperatures. Nitrogen dioxide (NO_2) is the most commonly monitored. Road fuel burning mainly produces NO, which reacts rapidly in the atmosphere to produce NO_2.

Sulphur dioxide (SO_2) is a gas which comes from burning fuels.

Ozone (O_3) is a gas made from oxygen in the Earth's atmosphere rather than being emitted directly. It's found naturally in the stratosphere, but it can also be both created and removed by chemical reactions with other sources of air pollution.

Sources of air pollution

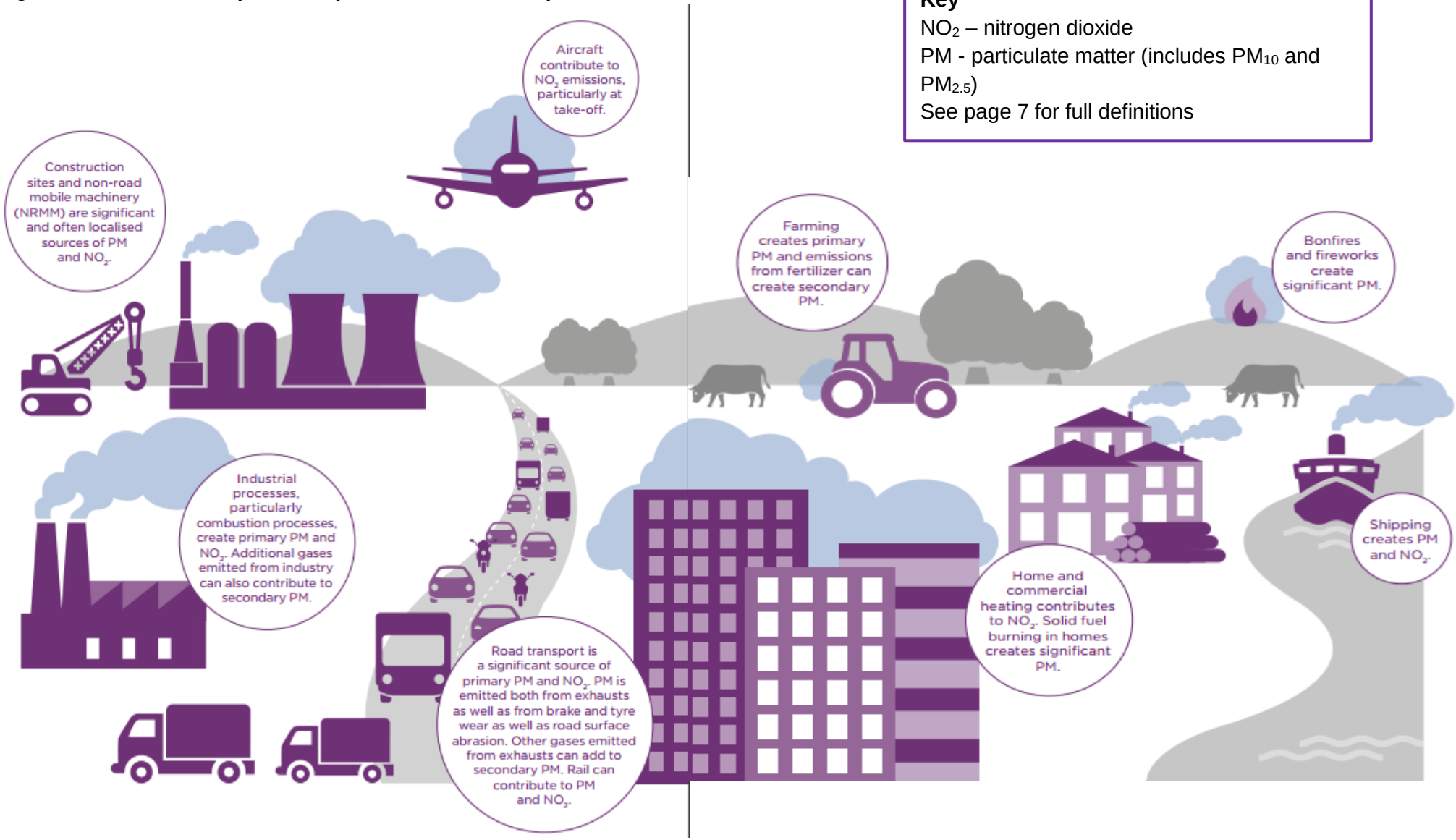
Air pollution comes from a range of local, national and international sources. Local factors can lead to major variations in air quality, with different communities affected by different problems: urban areas may have dense traffic on the roads, rural areas may be affected by agricultural processes, while coastal areas may be more affected by shipping. Nevertheless, air quality is affected by complex interactions between many different sources of pollution, as

[6] https://www.sciencedaily.com/terms/air_pollution.htm
[7] From DEFRA, PHE and LGA, Air Quality: a briefing for Directors of Public Health, 2017, http://www.adph.org.uk/wp-content/uploads/2017/03/6.3091_DEFRA_AirQualityGuide_9web.pdf (accessed January 2018)

well as by weather patterns, which means that not all of the sources of air pollution in an area can be addressed locally (see figure 2).[8]

[8] From DEFRA, PHE and LGA, Air Quality: a briefing for Directors of Public Health, 2017, http://www.adph.org.uk/wp-content/uploads/2017/03/6.3091_DEFRA_AirQualityGuide_9web.pdf (accessed January 2018)

Figure 2: sources of air pollution (source – reference 7)



Key

NO_2 – nitrogen dioxide

PM - particulate matter (includes PM_{10} and $PM_{2.5}$)

See page 7 for full definitions

Roads

Motorised road traffic is the single biggest contributor to NO_x and particulate matter (PM_{10}) in London.[9]

Pollution comes from both the burning of fuel, which can emit several different types of gas, and from wear-and-tear on brake pads, tyres, and road surfaces which can produce fine particles. All kinds of motorised road traffic can contribute to air pollution, but not all vehicles are the same. The type of fuel, and the vehicle's load and age can make a big difference. Diesel cars emit more NO_x and particulates than petrol cars: around a third of all UK NO_x emissions in 2015 came from road transport, and the majority of this was from diesel vehicles.[10]

The age of a vehicle also makes a big difference because European emissions standards have become stricter over time. Newer vehicles are manufactured to comply with the latest standards and should emit fewer pollutants than older vehicles if they are well maintained. Emissions of NO_x from passenger cars decreased by 83% between 1990 and 2015.[11]

Construction

Construction projects can create a lot of localised particulate matter through both the demolition and building process.[12] Associated industries such as quarrying and transport can further increase the impact of construction on air quality.

Industry and agriculture

Industrial processes, particularly those involving combustion of gas, oil or coal, can release many different by-products into the air. Power plants are responsible for roughly 50% of SO_2 emissions, and combustion (from both commercial and domestic sources) is also the main source of particulate emissions.[13] However, the amount of $PM_{2.5}$ from power stations has fallen by 91% since 1990.[14]

Agricultural processes result in the production of waste products entering the environment. Agriculture is the leading contributor to the production of ammonia, which can come from fertiliser and breakdown of urea (present in urine from farm animals).[15]

Domestic sources of air pollution

Fuel burning is the main source of air pollution from individual households. Domestic heating, bonfires and barbecues can generate a lot of particulate matter, particularly when burning solid fuel.[16]

Between 1990 and 2002, people used less coal to heat their homes and emissions from domestic solid fuel burning fell significantly. However, this trend has since been reversed

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[9] IPPR, Lethal and Illegal: London's Air Pollution Crisis, 2016
[10] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=6, (accessed December 2017)
[11] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=6, (accessed December 2017)
[12] http://naei.defra.gov.uk/overview/ap-overview
[13] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=24 (accessed December 2017)
[14] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=122 (accessed December 2017)
[15] See https://ec.europa.eu/environment/efe/themes/air/agricultural-sector-must-reduce-emissions-and-help-fight-air-pollution_en
[16] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=24 (accessed December 2017)

because of the growth in domestic wood burning, and overall domestic emissions of $PM_{2.5}$ are now back at around 1990 levels, with approximately 85% now coming from wood burning.[17]

Aviation

Aircraft engines are generally efficient and produce relatively low emissions, but pollution is greater at take-off and landing which can affect local air quality near airports.[18] This effect is compounded by higher levels of road traffic to and from airports, and by noise pollution for local communities near take-off and landing paths.

Natural factors affecting air pollution and its distribution

Relatively uncommon events such as volcanic eruptions and forest fires can produce SO_2 as well as other potentially harmful products of combustion.

Weather patterns can lead to the distribution of both natural and human-made pollutants hundreds of miles from their original source, and can either help to disperse pollution, or increase its intensity. For example, Saharan dust cloud episodes have been widely reported in the UK media, and a DEFRA-commissioned report has identified that climate change could make these events more common because of the northern spread of desertification.[19]

[17] National Atmospheric Emissions Inventory, http://naei.beis.gov.uk/overview/pollutants?pollutant_id=122 (accessed December 2017)

18 The International Civil Aviation Organization (ICAO) sets international standards for smoke and certain gaseous pollutants for newly-produced large jet engines; it also restricts the venting of raw fuels. https://www.icao.int

[19] Sami Consulting, STRATEGIC EVIDENCE OF FUTURE CHANGE Horizon Scanning evidence and analysis report (1) Appendices C and D Defra Partnership, p41 http://www.samiconsulting.co.uk/5defra1march2015appendicesCD.pdf, accessed 8 December 2017

4. Impact of air pollution on public health

What is the overall health impact?

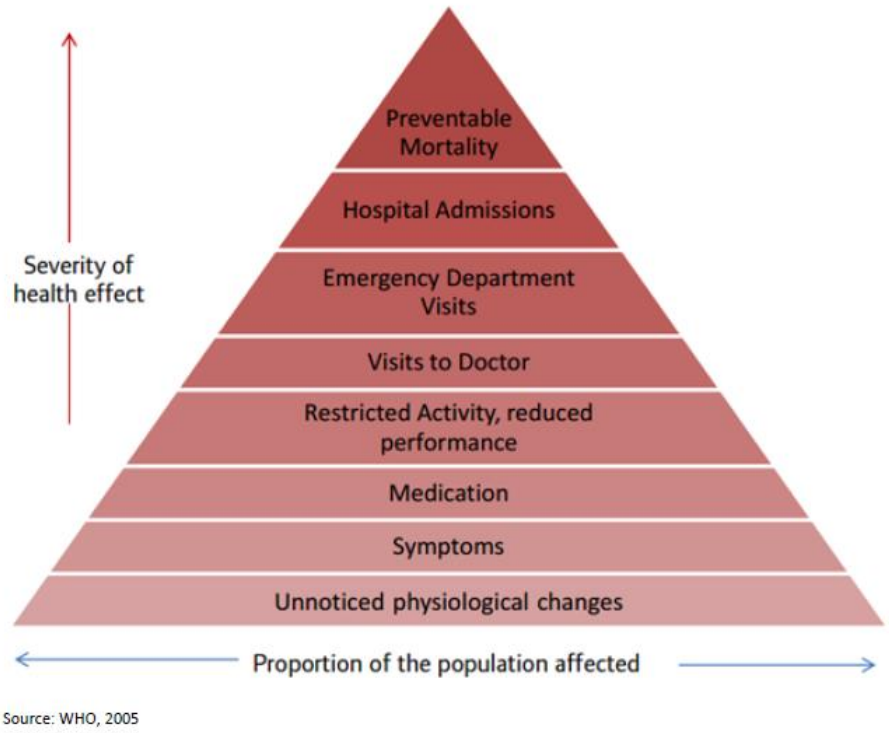
The Royal College of Physicians has estimated that the equivalent of around 40,000 deaths per year in the UK can be linked to the combined impact of particulate matter and NO_x[20]. If babies born in London in 2010 were exposed to the same levels of particulate matter throughout their lives as they were at their birth, then on average, they would lose at least nine months of life expectancy.[21]

Although international agencies including the EU have established limit values for key pollutants including particulates[22], there is evidence that long-term exposure to concentrations of $PM_{2.5}$ well below these limits is linked to health risks[23] [24]. The higher the concentration, the more significant the health impact, but no threshold has been found below which there are no health effects, so international guidelines aim to achieve the lowest possible concentrations.[25]

Air pollution can have both short- and long-term effects on people's health but it is the long-term build-up of harm over time that has the greatest overall impact. Figure 3 is the World Health Organisation's illustration of the health effects of air quality on a whole population, with many people experiencing mild or unnoticeable effects and fewer people experiencing the most severe impact.[26]

[20] Royal College of Physicians, *Every Breath We Take* (2016)
[21] King's College London, Understanding the health impacts of air pollution in London, 2015, p10 https://www.london.gov.uk/sites/default/files/hiainlondon_kingsreport_14072015_final.pdf (accessed December 2017)
[22] See section 8, Current Action on Air Quality
[23] Cesaroni et al, Long term exposure to ambient air pollution and incidence of acute coronary events: prospective cohort study and meta-analysis in 11 European cohorts from the ESCAPE Project, BMJ 2014; 348:f7412 https://doi.org/10.1136/bmj.f7412; Beelen et al, Lancet, 383, 9919, Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2813%2962158-3/abstract
[24] Beelen et al, Lancet, 383, 9919, Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2813%2962158-3/abstract
[25] WHO, 2016, Air Quality Factsheet http://www.who.int/mediacentre/factsheets/fs313/en/ (accessed December 2017)
[26] Taken from GLA, Air Quality in Kingston upon Thames: A guide for Public Health Professionals (accessed January 2018)

Figure 3: Pyramid of air pollution health effects



Who is affected? Air pollution and health inequalities

Air pollution can affect everyone, particularly in urban areas with a significant amount of traffic pollution, but there is a disproportionate impact on some groups of people, either because they are exposed to more pollution or because they are particularly vulnerable to it in some way.[27] The factors that put people at risk are often interrelated: age, sex, diet, income, body size and genetics can all play a part.

Nevertheless, in general, those who spend the most time in areas where air pollution is concentrated are at the greatest risk. In the UK, this particularly includes those who live or work near busy roads, or who drive for a living. This is because air pollution is typically at its highest at the emission source, and as the distance from the source increases, air pollution tends to decrease.

Children and young people

Children may be especially vulnerable to air pollution for many reasons. Their exposure may be higher because they breathe more quickly than adults and spend more time exercising outdoors.[28] Those in buggies and prams are also physically closer to car exhaust pipes.[29] As well as having higher exposure, children may also be more affected by air pollution because their lungs are not yet fully formed. There is evidence that exposure to high background

[27] Deguen S and Zmirou-Navier D, Social inequalities resulting from health risks related to ambient air quality—A European review, European Journal of Public Health, Vol. 20, No. 1, 27–35, 2010
[28] American Academy of Pediatrics Committee on Environmental Health, Policy Statement: Ambient Air Pollution: Health Hazards to Children, Pediatrics, 114, 6, 2004 http://pediatrics.aappublications.org/content/pediatrics/114/6/1699.full.pdf
[29] British Lung Foundation, How air pollution affects your children's lungs

levels of air pollution affects their lung function and development as well as their risk of having asthma.[30]

There is also a growing body of evidence suggesting that prenatal exposure to air pollution may be associated with adverse outcomes in pregnancy. These include low birth weight, still birth, intra uterine growth retardation and an increased risk of chronic disease in later life.[31]

Older people and people with health problems

The impact of short term episodes of poor air quality appears to particularly strongly affect older people, perhaps because they are more likely to already have health problems which are affected by pollution. For example, there are associations between high concentrations of air pollution and hospital admissions for cardiovascular conditions in older people.[32]

Both lung and heart conditions can make people more vulnerable. There is particularly strong evidence that air pollution affects lung function and worsens symptoms for people with asthma and COPD.[33]

Socio-economic status

People living in deprived areas are often exposed to higher concentrations of air pollution than those in wealthier areas, though there are exceptions in wealthy town centres.[34] [35] [36] Research carried out on behalf of DEFRA found that across England, the proportion of people exposed to the highest levels of PM_{10} was ten times as high in the most deprived groups than the least deprived.[37] London has a clear socioeconomic gradient in levels of exposure to NO_x and particulates, which may also affect people where they work and study, as well as where they live.[38] In 2010, 82% of the schools exposed to poor air quality in London were deprived schools (defined as having a high proportion of children receiving free school meals).[39]

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[30] Kulkarni & Grigg, Effect of Air Pollution on Children, 2008 https://www.sciencedirect.com/science/article/pii/S1751722208000280

[31] GLA, Air Quality in Kingston upon Thames: A guide for Public Health Professionals (accessed January 2018)

[32] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513338/

[33] Kelly FJ, & Fussell JC, 2011, Air pollution and airway disease. Clinical and Experimental Allergy, 41(8), 1059–1071.

[34] Local Government Association and Association of Directors of Public Health, Air Quality: A guide for Directors of Public Health, 2017 http://www.adph.org.uk/wp-content/uploads/2017/03/6.3091_DEFRA_AirQualityGuide_9web.pdf

[35] Milojevic et al. Socioeconomic and urban-rural differentials in exposure to air pollution and mortality burden in England, Environmental Health (2017) 16:104

[36] Goodman et al, Characterising socio-economic inequalities in exposure to air pollution: A comparison of socio-economic markers and scales of measurement, Health & Place Volume 17, Issue 3, May 2011, Pages 767- 774 http://www.sciencedirect.com/science/article/pii/S1353829211000220

[37] 20.3% and 2% respectively of the most and least deprived deciles lived in the 10% of areas with the highest PM10 concentrations, Pye et al, Air Quality and Social Deprivation in the UK: an environmental inequalities analysis, AEA Technology, 2006 https://uk-air.defra.gov.uk/assets/documents/reports/cat09/0701110944_AQinequalitiesFNL_AEAT_0506.pdf (accessed January 2018)

[38] Aether, 2013, Analysing Air Pollution Exposure in London, Report to the Greater London Authority, https://www.london.gov.uk/sites/default/files/analysing_air_pollution_exposure_in_london_-_technical_report_-_2013.pdf (accessed January 2018)

[39] Aether, 2013, Analysing Air Pollution Exposure in London, Report to the Greater London Authority, https://www.london.gov.uk/sites/default/files/analysing_air_pollution_exposure_in_london_-_technical_report_-_2013.pdf (accessed January 2018)

The 2010 Marmot Review of health inequalities highlighted that people in deprived areas also experience more adverse health effects at the same level of exposure compared to those from less deprived areas.[40] This may be because they are more likely to have health problems already. People with a lower socioeconomic status are at higher risk for many conditions which have also been linked to air pollution, including lung and heart diseases.[41] When considered separately, deprivation has a stronger relationship with poor health than exposure to air pollution does, and combining the two worsens the impact.[42]

Figure 4 is an illustration of the possible cumulative impact of air pollution and deprivation throughout someone's life.[43] Higher exposure can worsen health, in turn affecting life chances and making it more likely that exposure to pollution will continue, worsening health still further.

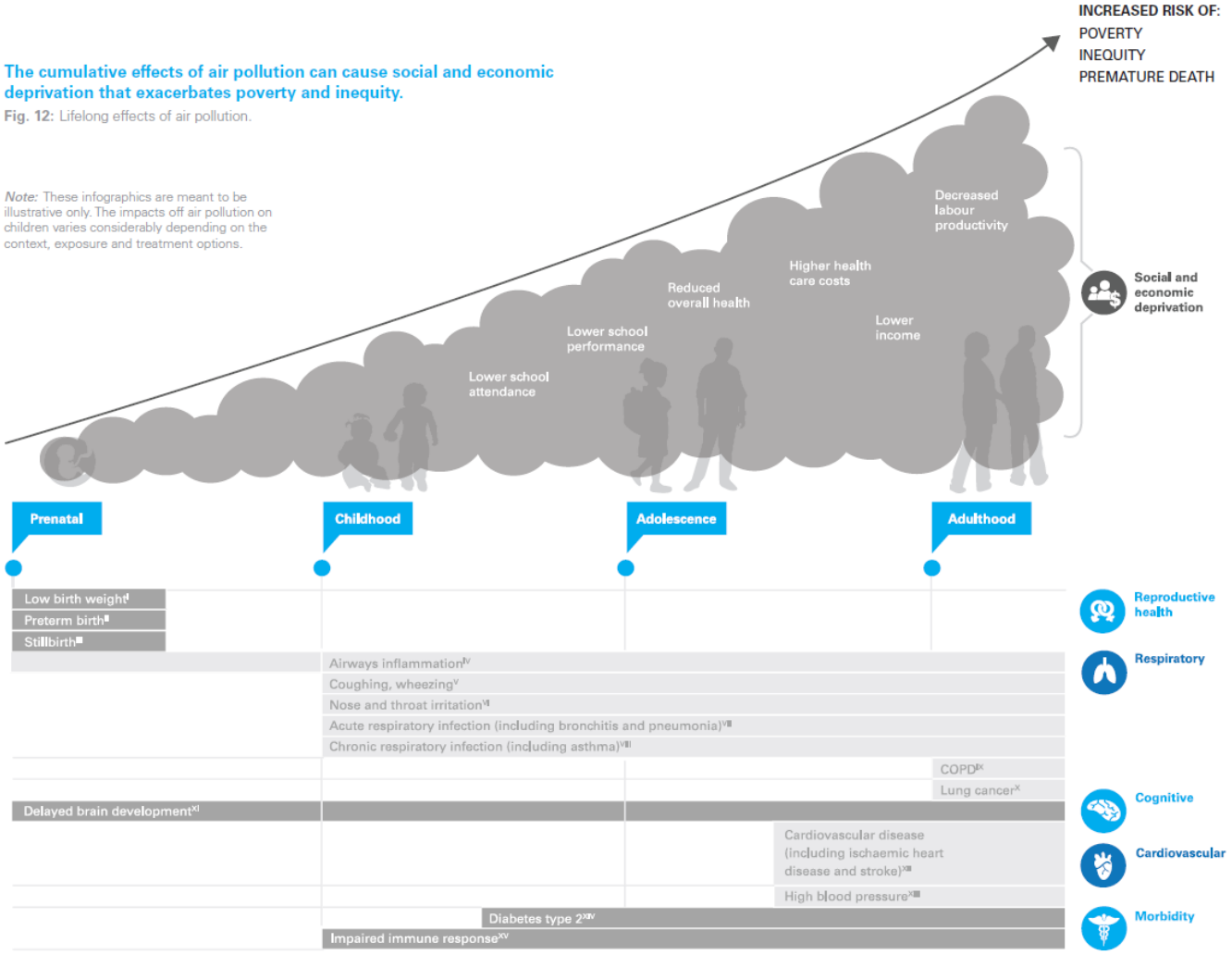
Road transport users

Since transport contributes a relatively high proportion of pollution in urban areas, some researchers have investigated whether there are differences in how much people are exposed to air pollution depending on how they travel. These studies have shown that people who travel in cars, buses and taxis are exposed to a higher concentration of pollutants than cyclists or pedestrians, though longer journey times do increase their overall exposure.[44] This is because air pollution is typically more concentrated in vehicle cabins within traffic lanes than in the outside air nearby.

Cyclists and pedestrians will be less exposed to pollution if they choose a quieter route. Analysis of key central London walking routes by King's College London in 2017 found that taking a side street reduced pollution exposure by 53%.[45]

[40] Marmot M et al, Fair Society, Healthy Lives, 2010
[41] Prescott and E and Vestbo J, Socioeconomic status and COPD, Thorax, 1999
[42] Brunt H et al, Air pollution, deprivation and health: understanding relationships to add value to local air quality management policy and practice in Wales, UK. J Public Health (Oxf). 2017 Sep 1;39(3):485-497.
[43] From UNICEF, Clear the air for children, 2016, https://www.unicef.org/publications/files/UNICEF_Clear_the_Air_for_Children_30_Oct_2016.pdf (accessed January 2018)
[44] Cepeda M et al, Levels of ambient air pollution according to mode of transport: a systematic review The Lancet Public Health, Volume 2, Issue 1, January 2017, Pages e23-e34
[45] The Guardian, Side street routes to avoid city pollution cut exposure by half, June 2017 https://www.theguardian.com/environment/2017/jun/14/side-street-routes-avoid-city-pollution-cut-exposure-by-half (accessed January 2018)

Figure 4: lifelong effects of air pollution
(Source: UNICEF, Clear the Air for Children)



Which health conditions are linked to pollution?

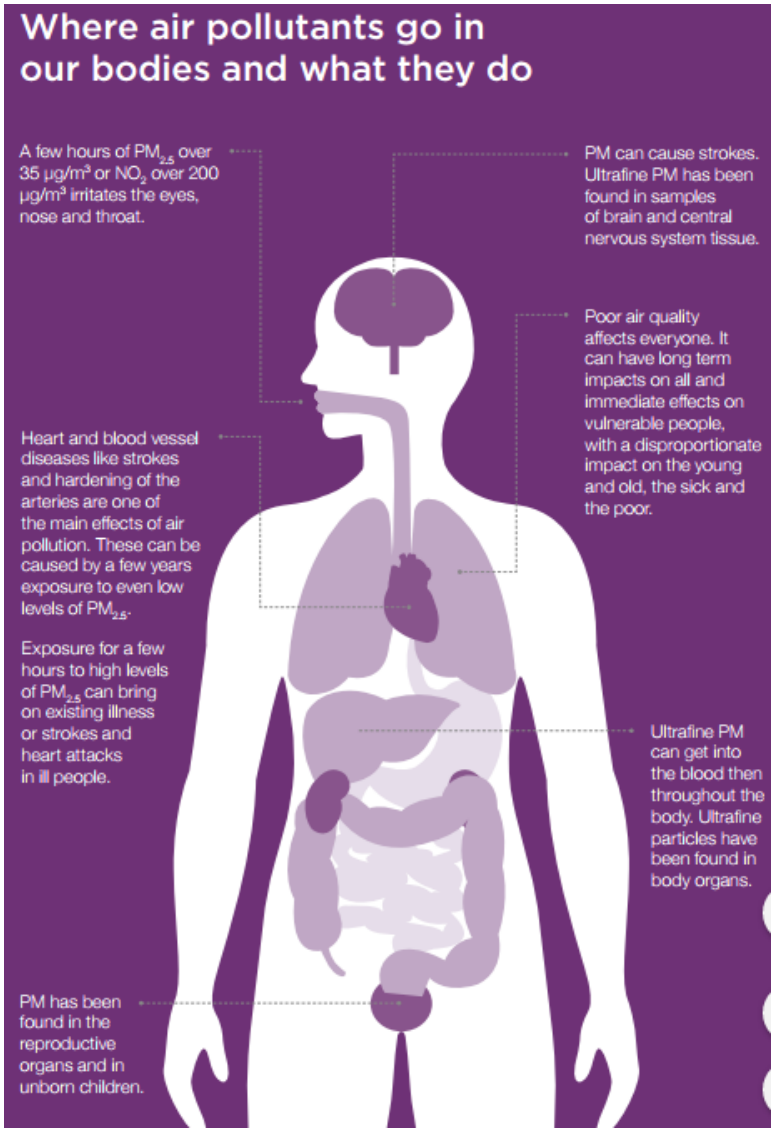
Poor air quality can contribute to early deaths from many causes, with the most common being stroke, followed by heart disease, chronic obstructive pulmonary disease (COPD), lung cancer and acute respiratory infections.[47]

Short term exposure to pollution aggravates existing health conditions including heart, circulatory and lung conditions. In particular, a systematic review of evidence found that there is a direct causal relationship between air pollution and asthma attacks[48] and the Committee on the Medical Effects of Air Pollution has concluded that there is likely to be a causal link between high daily pollution levels and cardiovascular deaths and hospital admissions.[49]

Long-term exposure to air pollution also affects lung and cardiovascular health. Many experts agree that air pollution contributes to the onset of asthma in childhood and to cardiovascular disease later in life.[50] In addition, in 2012, the International Agency for Research on Cancer listed diesel exhaust pollution as a Class 1 carcinogen and extended this to all ambient air pollution in 2013[51].

Emerging evidence also links long-term pollution exposure to diabetes, obesity and changes linked to dementia, as well as impacts on mental and physical development in children and cognition in older people.[52] In addition, exposure to air pollution may increase vulnerability to infections.[53]

Figure 5: where air pollutants go in our bodies and what they do[46]



[46] From DEFRA, PHE and LGA, Air Quality: a briefing for Directors of Public Health, 2017, http://www.adph.org.uk/wp-content/uploads/2017/03/6.3091_DEFRA_AirQualityGuide_9web.pdf (accessed January 2018)
[47] WHO, Burden of disease from ambient air pollution 2012, http://www.who.int/phe/health_topics/outdoorair/databases/FINAL_HAP_AAP_BoD_24March2014.pdf?ua=1 (accessed January 2018)
[48] Orellano et al, Effect of outdoor air pollution on asthma exacerbations in children and adults: Systematic review and multilevel meta-analysis, PLoS One. 2017 Mar 20;12(3)
[49] COMEAP, Cardiovascular disease and air pollution, 2006
[50] Aphekom, Summary Report of the Aphekom http://web.archive.org/web/20130807083807/http://www.aphekom.org:80/c/document_library/get_file?uuid=5532fafa-921f-4ab1-9ed9-c0148f7da36a&groupId=10347 (accessed February 2018)
[51] https://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf
[52] GLA, Air Quality in Kingston upon Thames: A guide for Public Health Professionals (accessed January 2018)
[53] Kulkarni & Grigg, Effect of Air Pollution on Children, 2008 https://www.sciencedirect.com/science/article/pii/S1751722208000280

A summary of both the sources and the specific health effects of particular pollutants can be found in Appendix A.

5. Air quality and public health in Kingston

Overall air quality in Kingston

Air quality across London, including in Kingston, has improved substantially since the 1990s, primarily as a result of policies designed to reduce emissions from road transport. However, it remains an important public health issue, and the latest pollution concentration data show that national and European annual pollution limits are still being exceeded in some areas of the borough.[54]

NO_2 and particulates are the main pollutants of concern in Kingston. Despite a longer-term trend for reductions in levels of NO_2, the latest annual Air Quality Status Report for Kingston upon Thames highlights that the overall levels of NO_2 have increased in the borough.[55] However, reductions in particle emissions over recent years have resulted in lower annual average concentrations of PM_{10} in Kingston, and the borough is now compliant with EU PM_{10} limit values.[56]

Figure 6 maps NO_2 concentrations in Kingston in 2013, the year used as the baseline for London-wide modelling. Although this data is relatively old, using it enables more detailed comparison with other areas and future projections. Estimates from the Greater London Authority's London Atmospheric Emissions Inventory (LAEI) suggest that there are still likely to be areas of Kingston which do not meet EU limit values for NO_2 by 2020 unless further action is taken.

Full details of past, recent and projected levels of NO_x, NO_2, PM_{10} and $PM_{2.5}$ are included in Appendix B. According to these figures, the single greatest contributor to emissions in Kingston is road transport, which is responsible for 61% of PM_{10}, 72% of $PM_{2.5}$ and 58% of NO_x in the area.[57]

Although traffic flows in Kingston have decreased over the past two decades, there has been an increase in the number of vehicle registrations, particularly for diesel vehicles. The total number of vehicle registrations in Kingston increased by 4.5% between 2009 and 2016. This was a slightly higher increase than for London as a whole (4.2%), but a smaller increase than for England (10.0%). However, the number of diesel cars and vans registered in the area has gone up much more quickly, rising by 57.3%, and increasing from just over a fifth (21.5%) of all vehicles to just under a third (32.4%) over the same period.[58]

Since diesel vehicles contribute more to NO_x and particulate air pollution than other vehicle types, this sharp increase may be part of the explanation for increases in NO_x reported during the last three years. Neighbouring boroughs also saw sharp increases in registration of diesel cars, which may be contributing to Kingston's air pollution as they visit or drive through the borough.

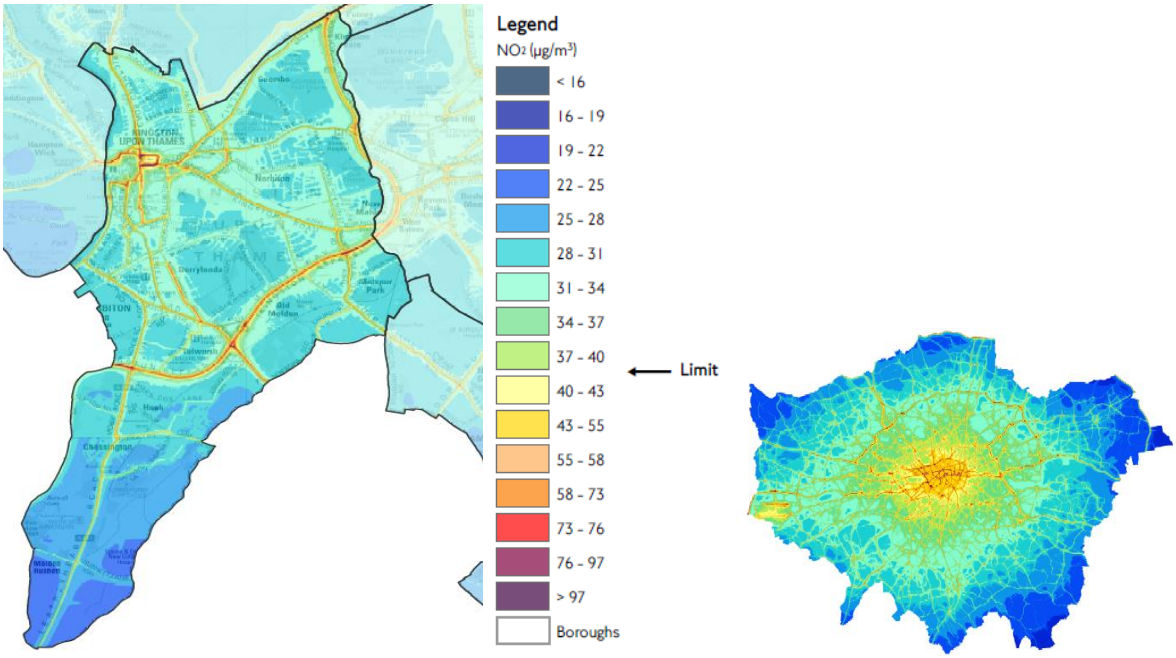
No recent local figures for Kingston are available to tell us overall what proportion of people use each mode of transport for their typical journeys, but this is measured for Outer London as a whole. According to the

[54] London Atmospheric Emissions Inventory, 2017, London datastore, https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2013 and https://data.london.gov.uk/dataset/llaqm-bespoke-borough-by-borough-air-quality-modelling-and-data (accessed January 2018)
[55] Royal Borough of Kingston Annual Air Quality Status Report for 2015, 2016 https://www.kingston.gov.uk/downloads/file/1761/rbk_kingston_annual_status_report_2016 (accessed January 2018)
[56] London Atmospheric Emissions Inventory, 2017, London datastore, https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2013 and https://data.london.gov.uk/dataset/llaqm-bespoke-borough-by-borough-air-quality-modelling-and-data (accessed January 2018)
[57] See tables in Appendix B.
[58] See tables in Appendix C.

London Travel Demand Survey 2015-16, 24.9% of journeys in Outer London are walked, a decline of 3.8 percentage points since the survey began in 2005-6. The proportion of journeys that are cycled has risen from 1.1% to 1.7% over the same period. The combined figure for journeys as either a car driver or passenger was 47.2% in 2015-16.[59] More local figures would give us a more accurate understanding of the impact of people's transport choices, but these figures do suggest that there is scope for more cycling and walking in Outer London as a whole.

There is more information about trends in vehicle registration and traffic flows in Kingston and surrounding areas in Appendix C.

Figure 6: annual mean NO_2 concentrations for 2013 in Kingston and London (Source: LAEI 2017)



Alongside measurement of NO_2 and particulate matter the Council has also assessed and screened benzene, 13 butadiene, carbon monoxide (CO), lead and sulphur dioxide (SO_2) and has found that the concentration of these pollutants are not likely to exceed the air quality objectives.

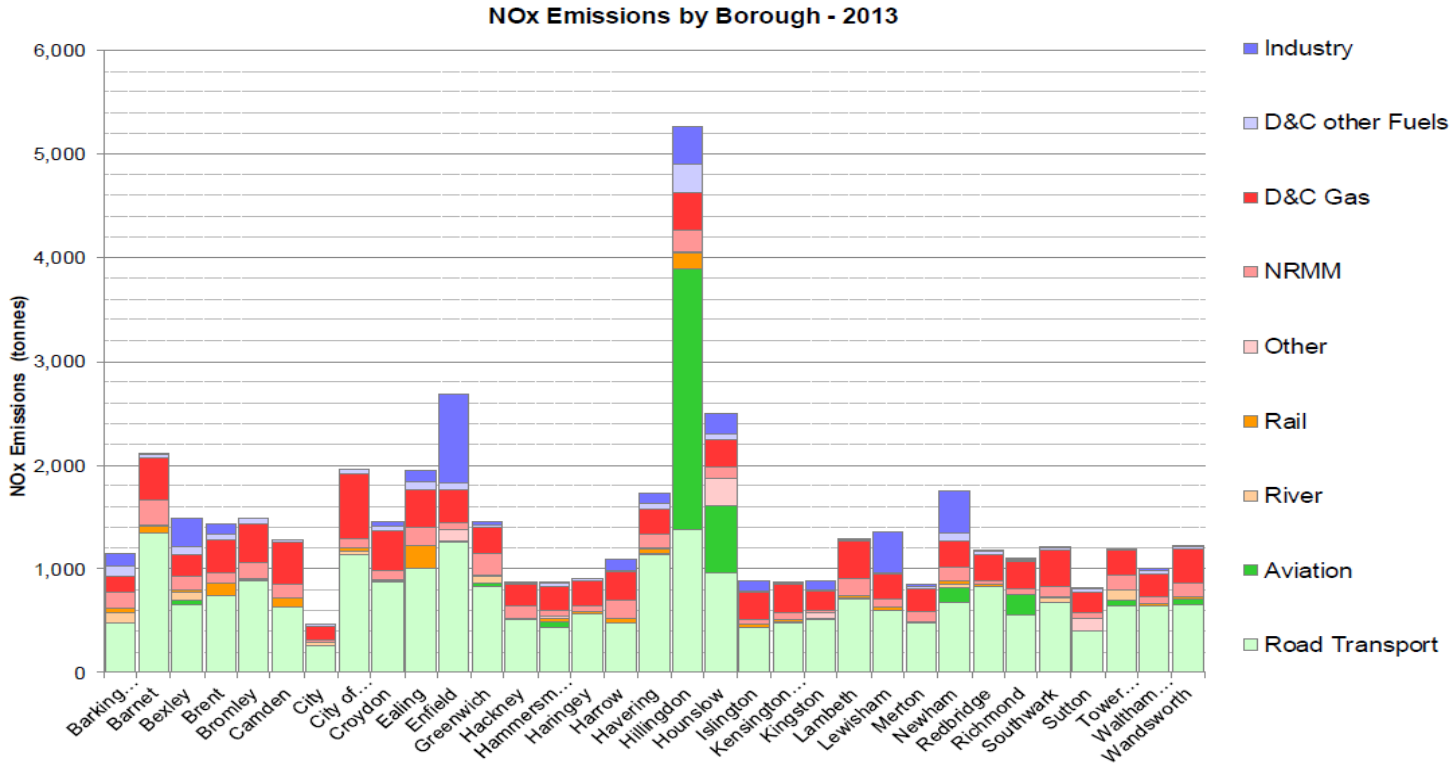
How does Kingston compare to the rest of London?

Figure 7 compares total NO_x emissions and their sources in all London boroughs in 2013. It indicates that emission levels in Kingston are similar to those in the neighbouring outer London boroughs of Sutton and Merton, and lower than in many inner London boroughs, including neighbouring Wandsworth.

Although flight paths into Heathrow Airport pass over the borough, this graph shows that the contribution of aviation to local air pollution in Kingston is relatively low. Heathrow generates a significant amount of air pollution, but this is concentrated in areas closer to the airport itself. [60] Nevertheless, airport expansion has the potential to affect Kingston's air quality by changing road traffic patterns.

[59] London Travel Demand Survey 2015-16, available at https://tfl.gov.uk/corporate/publications-and-reports/london-travel-demand-survey (accessed January 2018)
[60] Information on the environmental impact and air quality impact of airports and aeroplanes can be found at http://publicapps.caa.co.uk/docs/33/CAP1524EnvironmentalInformation29032017.pdf

Figure 7: NO_x emissions by London borough



Note: D&C denotes Domestic and Commercial, NRMM denotes Non Road Mobile Machinery
Borough names that do not appear fully on the above chart are Barking and Dagenham, City of Westminster, Hammersmith and Fulham, Kensington and Chelsea, Tower Hamlets and Waltham Forest

Source: LAEI Workshop 14th April 2016, TfL

Local air quality hotspots

There is substantial variation in pollution concentrations around the borough. Areas with high levels of traffic congestion consistently have higher concentrations of pollutants, particularly areas close to Kingston town centre and along parts of the A3.

Overall air quality hotspots

Air quality is a key indicator considered within the Living Environment domain of the Indices of Multiple Deprivation (IMD) 2015. Using data from the National Atmospheric Emissions Inventory (NAEI), analysts have produced an air quality score for each small area (known as a Lower Super Output Area or LSOA) based on concentrations of four pollutants: nitrogen dioxide, particulate matter, benzene and sulphur dioxide.

There are 98 LSOAs in Kingston, and like many parts of London, most rank relatively poorly for air quality compared to the rest of England. Only four areas in Kingston are within the least disadvantaged half of the country. Table 1 shows the five LSOAs with the highest and lowest ranking for air quality in Kingston.

Table 1: Kingston's most and least disadvantaged areas in terms of air quality (see map in figure 9)

Worst air quality in Kingston	Best air quality in Kingston
Canbury Park Road/Clifton Road Area	Garrison Lane Area
Cambridge Road Estate	Chessington World of Adventures/Malden Rushett Area
Birkenhead Avenue to Hawks Road Area	Gilders Road/Rollesby Road Area
Kingston Town Centre Area	Compton Road/Padbury Rise Area
Princes Avenue/Largewood Avenue Area	Leatherhead Road/Cheshire Gardens area

Source: English Indices of Multiple Deprivation, 2015

Nitrogen dioxide hotspots

The Council also monitors NO_2 pollution specifically. In 2016, this was measured at two continuous monitoring stations (automatic) and at 40 diffusion tube (non-automatic) locations. A review of the monitoring network and locations has taken place and in 2018, the number of automatic monitoring stations is being increased to three. The results are compared against two objectives based on limit values set by the EU. The hourly objective is intended to protect people from being exposed to very high concentrations during episodes of severe pollution. The annual objective is the average concentration over a whole year, and is meant to protect people from ongoing exposure to NO_2.

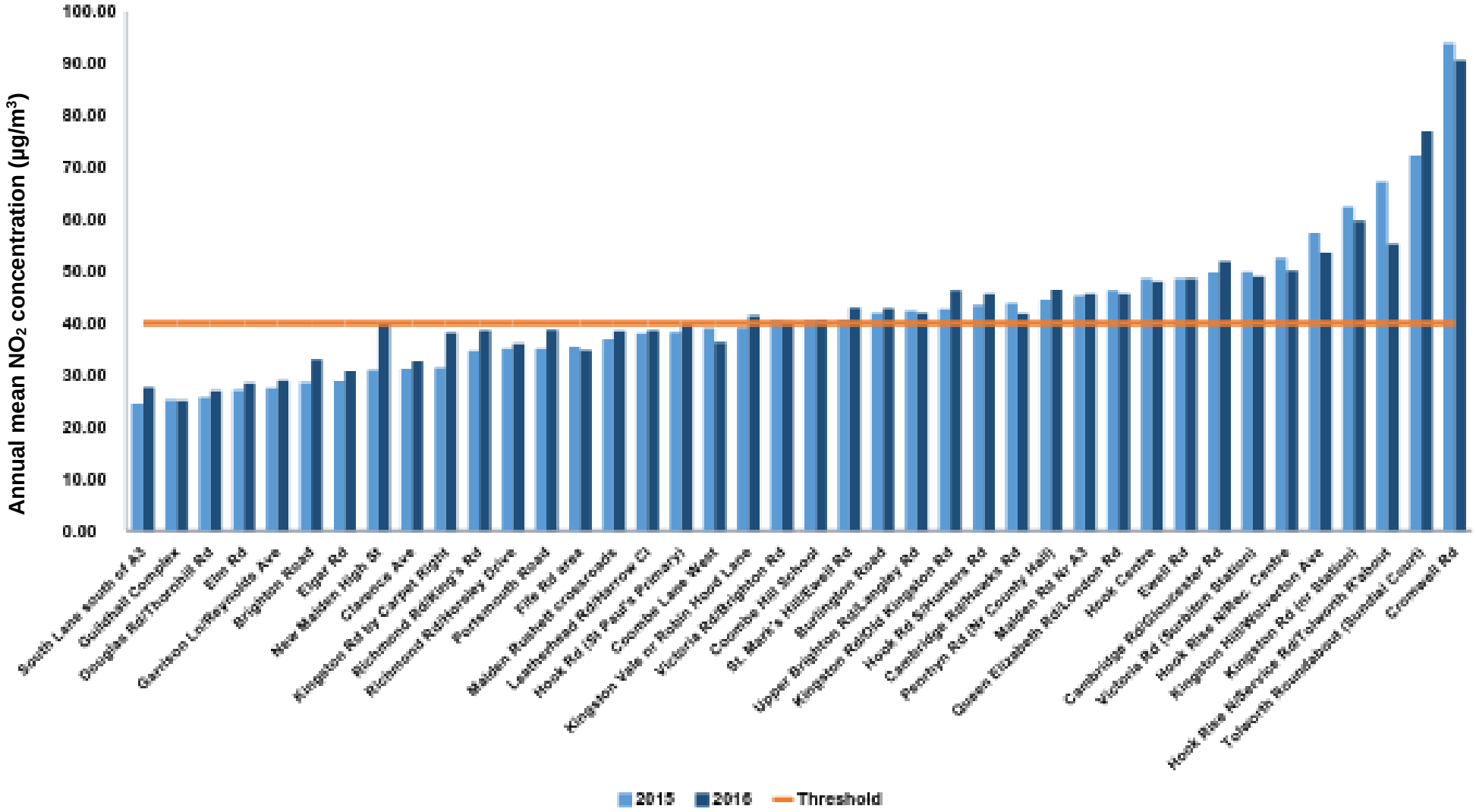
The most recent results highlight that in 2016:

- the two continuous monitoring sites exceeded the annual mean NO_2 objective of 40µg/m^3
- the annual mean objective for NO_2 was also exceeded at 23 out of 40 of the diffusion tube locations
- the non-automatic monitors near Tolworth Roundabout and Kingston Road (near station) sites exceeded 60µg/m^3, which indicates that the hourly objective could be exceeded in these places
- the highest concentration was 90.6µg/m^3 and was recorded at a site on the A307 Cromwell Road, one of the busiest roads in the borough
- all 4 results from diffusion tubes located along the A3 Malden Way exceeded the objective at the roadside.

Figure 8 shows changes in (non-automatic) monitoring of emissions of NO_2 between 2015 and 2016 and indicates which monitoring stations exceeded the annual mean objective. The monitoring sites with the highest recorded levels of NO_2 were at the 14-16 Cromwell Road and Tolworth Roundabout sites, both of which have extensive traffic congestion at busy times.

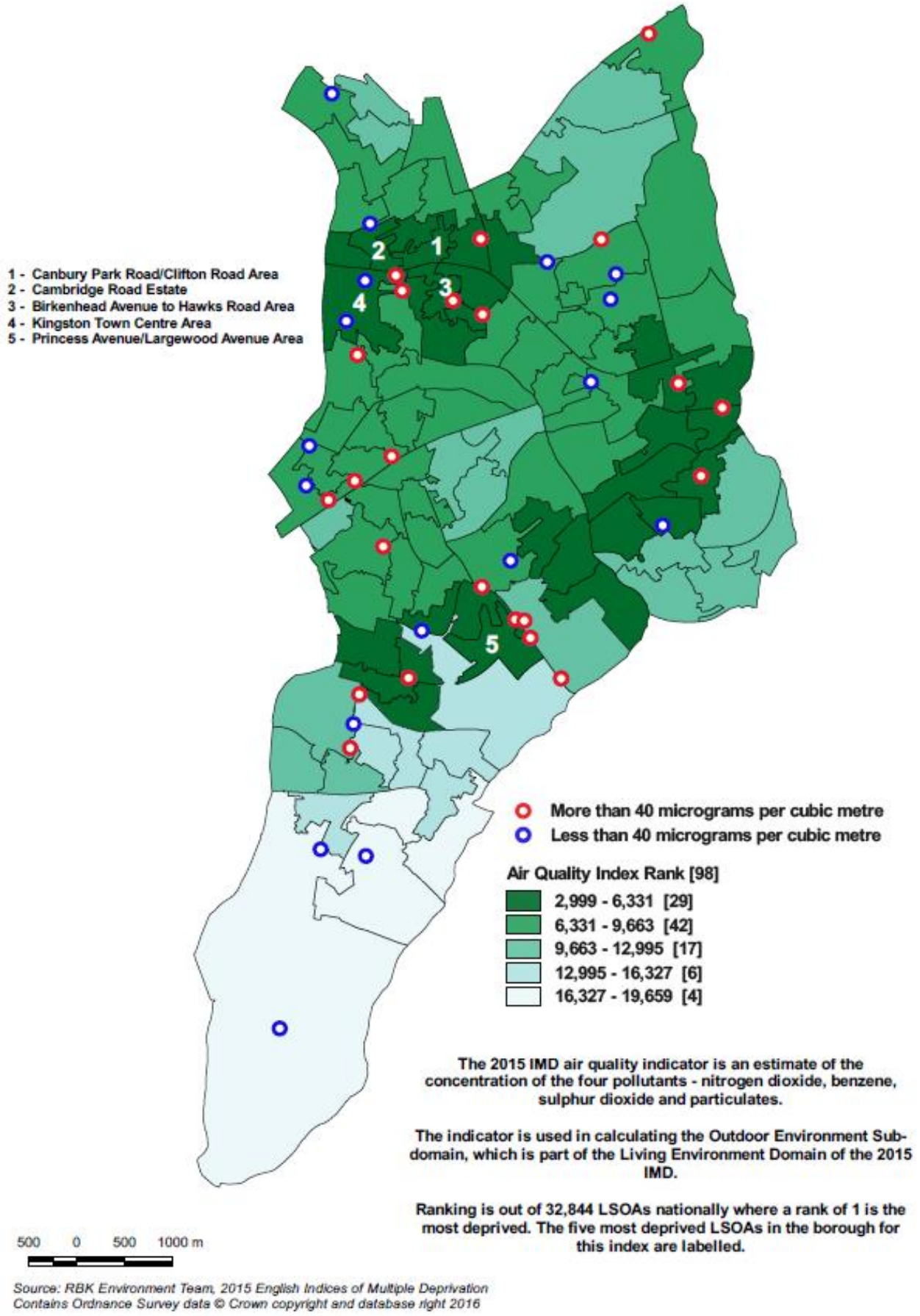
Figure 9 is a map showing the locations of the air quality monitors and their results in 2016, overlaid with the air quality index from the outdoor environment domain of the Index of Multiple Deprivation. Most of the areas highlighted with both high levels of NO_2 and a high ranking for environmental disadvantage are either close to Kingston town centre or to the A3.

Figure 8: Mean NO_2 measurements at 40 locations in the borough, 2015-2016 (threshold set at EU limit value of 40 µg/m^3)



Source: Royal Borough of Kingston upon Thames, 2016

Figure 9: LSOA Air Quality Index rank for Kingston, showing NO_2 monitor locations in 2016 and the five LSOAs with the poorest air quality in 2015



Source: RBK Environment Team, 2015 English Indices of Multiple Deprivation
Contains Ordnance Survey data © Crown copyright and database right 2016

Air quality and educational institutions

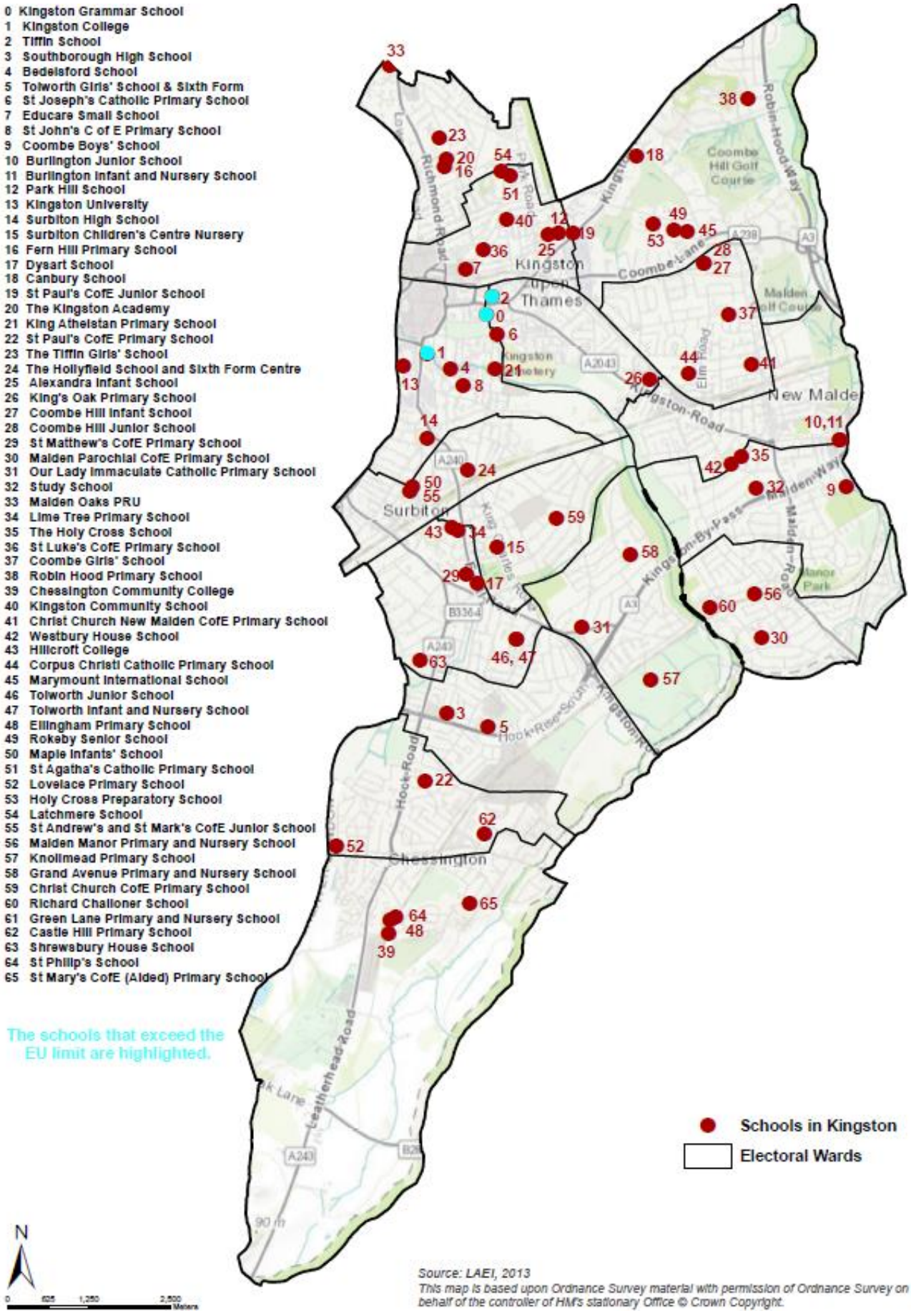
Because children and young people are particularly vulnerable to the effects of poor air quality, there is concern about exposure to pollution in schools and childcare facilities.

In Kingston, there are 36 primary and 11 secondary schools providing free education to children aged four to 18 years, with two new schools proposed for the future. Transport for London has analysed pollution concentrations within 150m of these schools and some independent schools and colleges, examining 66 institutions using 2013 air pollution maps. The average NO_2 concentration within a 150m buffer around each school was used to assess air pollution exposure.

Figure 10 maps school locations. Three educational establishments in Kingston were exposed to more than the annual mean NO_2 EU limit value of 40 µg/m^3: Kingston College, Kingston Grammar School and Tiffin School (Boys), all of which are located in Kingston town centre, where road traffic is a major contributor to air pollution.

Although only three educational establishments were in areas which exceeded annual EU mean limit values for NO_2 in 2013, many others had concentrations close to that level. NO_2 levels rose at some local air quality monitoring tubes between 2015 and 2016, and action to improve air quality around a number of Kingston schools would be of benefit to population health. Table 2 identifies the average (mean) level of NO_2 for all 66 educational institutions in Kingston in 2013.

Figure 10: Air quality exposure per educational establishment in Kingston, 2013



Source: LAEI, 2013

This map is based upon Ordnance Survey material with permission of Ordnance Survey on behalf of the controller of HM's stationary Office © Crown Copyright.

Table 2: NO_2 mean concentrations per educational establishment in 2013

Establishment name	Type of Establishment	Phase of education	NO_2ug/m3 mean 2013
Kingston Grammar School	Other Independent School	Not applicable	47.4
Kingston College	Further Education	16 Plus	43.1
Tiffin School	Academy Converter	Secondary	42.8
Southborough High School	Academy Converter	Secondary	39.2
Bedelsford School	Foundation Special School	Not applicable	38.9
Tolworth Girls' School & Sixth Form	Academy Converter	Secondary	38.1
St Joseph's Catholic Primary School	Voluntary Aided School	Primary	37.5
Educare Small School	Other Independent School	Not applicable	37.5
St John's C of E Primary School	Voluntary Aided School	Primary	37.3
Coombe Boys' School	Academy Converter	Secondary	35.9
Burlington Junior School	Community School	Primary	35.8
Burlington Infant and Nursery School	Community School	Primary	35.8
Park Hill School	Other Independent School	Not applicable	35.7
Kingston University	Higher Education Institutions	Not applicable	35.5
Surbiton High School	Other Independent School	Not applicable	35.4
Surbiton Children's Centre Nursery	LA Nursery School	Nursery	34.9
Fern Hill Primary School	Community School	Primary	34.5
Dysart School	Community Special School	Not applicable	34.3
Canbury School	Other Independent School	Not applicable	34.0
St Paul's CofE Junior School	Voluntary Aided School	Primary	33.7
The Kingston Academy	Free Schools	Secondary	33.6
King Athelstan Primary School	Community School	Primary	33.3
St Paul's CofE Primary School	Voluntary Aided School	Primary	33.2
The Tiffin Girls' School	Academy Converter	Secondary	33.1
The Hollyfield School and Sixth Form Centre	Academy Converter	Secondary	32.9
Alexandra Infant School	Community School	Primary	32.5
King's Oak Primary School	Community School	Primary	32.4
Coombe Hill Infant School	Community School	Primary	32.4
Coombe Hill Junior School	Community School	Primary	32.4
St Matthew's CofE Primary School	Voluntary Aided School	Primary	32.4
Malden Parochial CofE Primary School	Voluntary Aided School	Primary	32.2
Our Lady Immaculate Catholic Primary School	Voluntary Aided School	Primary	32.2
Study School	Other Independent School	Not applicable	31.9
Malden Oaks PRU	Pupil Referral Unit	Not applicable	31.8
Lime Tree Primary School	Foundation School	Primary	31.7
The Holy Cross School	Academy Converter	Secondary	31.5
St Luke's CofE Primary School	Foundation School	Primary	31.4
Coombe Girls' School	Academy Converter	Secondary	31.4
Robin Hood Primary School	Community School	Primary	31.3
Chessington Community College	Community School	Secondary	31.3
Kingston Community School	Free Schools	Primary	31.0
Christ Church New Malden CofE Primary School	Voluntary Aided School	Primary	31.0

Westbury House School	Other Independent School	Not applicable	30.9
Hillcroft College	Miscellaneous	Not applicable	30.8
Corpus Christi Catholic Primary School	Voluntary Aided School	Primary	30.6
Marymount International School	Other Independent School	Not applicable	30.5
Tolworth Junior School	Community School	Primary	30.5
Tolworth Infant and Nursery School	Community School	Primary	30.5
Ellingham Primary School	Community School	Primary	30.5
Rokeby Senior School	Other Independent School	Not applicable	30.4
Maple Infants' School	Community School	Primary	30.4
St Agatha's Catholic Primary School	Academy Converter	Primary	30.4
Lovelace Primary School	Community School	Primary	30.4
Holy Cross Preparatory School	Other Independent School	Not applicable	30.3
Latchmere School	Academy Converter	Primary	30.3
St Andrew's and St Mark's CofE Junior School	Voluntary Aided School	Primary	30.3
Malden Manor Primary and Nursery School	Community School	Primary	30.0
Knollmead Primary School	Academy Sponsor Led	Primary	29.9
Grand Avenue Primary and Nursery School	Community School	Primary	29.8
Christ Church CofE Primary School	Voluntary Aided School	Primary	29.7
Richard Challoner School	Academy Converter	Secondary	29.4
Green Lane Primary and Nursery School	Community School	Primary	29.0
Castle Hill Primary School	Academy Converter	Primary	29.0
Shrewsbury House School	Other Independent School	Not applicable	28.8
St Philip's School	Community Special School	Not applicable	28.3
St Mary's CofE (Aided) Primary School	Voluntary Aided School	Primary	28.3

Source: LAEI 2013

Public health effects of air pollution in Kingston

Attributable deaths

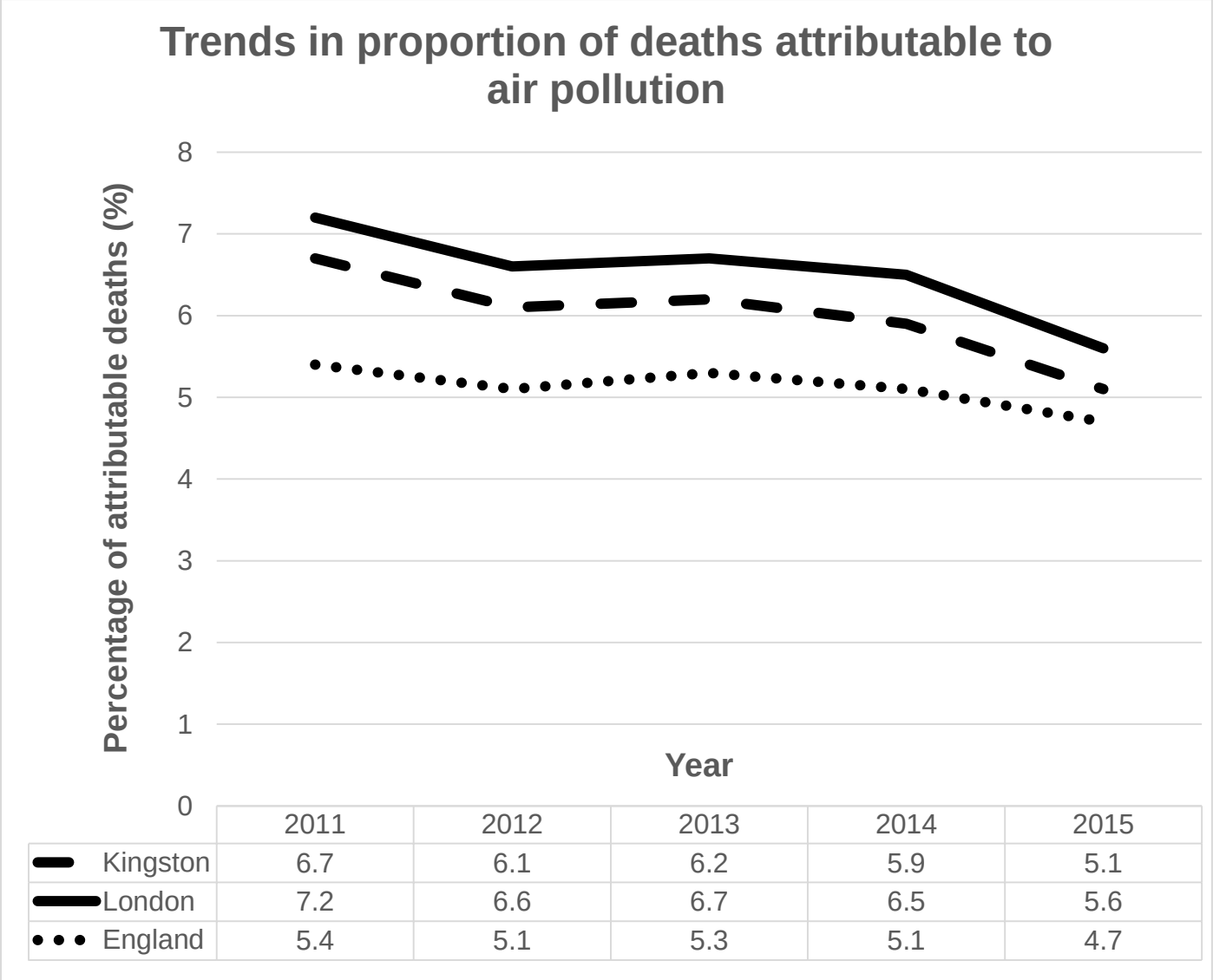
Public Health England has estimated that in 2010, Kingston had the equivalent of 68 deaths (or the loss of 730 years of life) as a result of exposure to man-made particulates.[61] This is a higher proportion of deaths than for England as a whole, but lower than the London average. In line with improvements to concentrations of particulates, the proportion of deaths attributable to particulates has declined, but is still the equivalent of around one in every twenty deaths (figure 11). No local estimate of deaths attributable to NO_x is available.

Estimating the number of people who have died, been admitted to hospital, or developed a health problem as a result of air pollution is complex. It is important to note that the number of deaths presented here is based on a statistical model and not on health records showing the causes of death for identifiable individual people.

A more detailed discussion of the methods behind this and an alternative estimate which includes an estimate of the equivalent number of deaths at ward level can be found in Appendix D.

[61] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf

Figure 11: trends in proportion of deaths attributable to air pollution



	2011	2012	2013	2014	2015
Kingston	6.7	6.1	6.2	5.9	5.1
London	7.2	6.6	6.7	6.5	5.6
England	5.4	5.1	5.3	5.1	4.7

Source: Public Health Outcomes Framework

Vulnerable people

Kingston's population includes 37,555 children aged under 18, and 22,984 people aged over 65.[62] The population registered with Kingston GPs is higher than the estimated resident population. According to Kingston's GP practice records, the local population also includes:

- 9,491 people with asthma (4.7% of people registered with Kingston GP practices) [63]
- 2,294 people with COPD (1.1% of people registered with Kingston GP practices)[64]
- 4,176 people with chronic heart disease (2.1% of people registered with Kingston GP practices)[65]

[62] Royal Borough of Kingston, Annual Public Health Report, 2016-17
[63]Public Health England, INHALE, QOF prevalence of asthma (all ages), 2015-16 https://fingertips.phe.org.uk/profile/inhale/data#page/1/gid/8000003/pat/46/par/E39000018/ati/153/are/E38000090/iid/253/age/1/sex/4
[64]Public Health England, INHALE, QOF prevalence of COPD (all ages), 2015-16 https://fingertips.phe.org.uk/profile/inhale/data#page/1/gid/8000003/pat/46/par/E39000018/ati/153/are/E38000090/iid/253/age/1/sex/4
[65] Public Health England, Cardiovascular Disease Profile, QOF prevalence of CHD, 2016-17, https://fingertips.phe.org.uk/profile/cardiovascular/data#page/0

These people may be particularly vulnerable to the effects of exposure to air pollution and should be aware of public health advice about how to respond to particularly severe episodes of air pollution.

6. Community Voice

In 2015, Kingston Council held a consultation on its current Kingston Air Quality action plan. This enabled residents to put across their views on the Council's plans. Cycle storage provision scored particularly highly compared to other actions.

Residents also proposed the following:

- more green along the A3
- expansion of non-car transportation methods
- action on engine idling
- change to the way cars and cyclists were treated
- buses in the future should be low-emission
- more trees should be present to trap particulate matters
- planning systems should be used to improve the way transport moves and is provided for
- go beyond "the minimum" for cycle provision in new developments
- reduced speed limits on residential roads and the A3

Concerns were also expressed that allocating more space to buses would increase car congestion.

Discussion with the Kingston Environment Forum, a group of interested residents and businesses in Kingston, raised similar concerns. Members of this group would like to see an expansion of work to improve air quality in Kingston, and raised the following issues:

- a wish to see London reach over 50% green space (in the context of a proposal for a London National Park)
- a need for a new approach to improve the environment for walking and cycling
- stopping engine idling, particularly near to schools
- the extension of 20 mph limits

7. What works?

Most evidence suggests a clear linear relationship between the amount of exposure to particulate matter and the amount of harm it does to health. There is also good evidence that any reduction in exposure will quickly lead to improvements in people's health.[66] Because more deprived groups tend to be exposed to more pollution, and to be more affected by it, it has also been suggested that action to improve air quality will also reduce health inequalities. This means that there is a strong case for action to improve air quality where possible.[67]

Evidence-based guidance from the National Institute for Health and Care Excellence (NICE) makes seven recommendations about what works to reduce traffic-related air pollution.[68]

1. planning
2. development management
3. clean air zones
4. reducing emissions from public sector transport services and vehicle fleets
5. smooth driving and speed reduction
6. walking and cycling
7. awareness raising

1. Planning

NICE recommends that, when planning, local authorities should consider siting and designing new buildings, facilities and estates to reduce the need for motorised travel and including motorised charging points and support for car clubs. NICE also recommends minimising pollution exposure by locating living accommodation away from roads, and avoiding siting buildings where there will be vulnerable people (such as schools, nurseries and care homes) in areas where pollution levels will be high.

When considering the streets, building configurations that encourage pollution to build up where people spend time should be avoided. For example, narrow streets between many tall buildings can create 'street canyons' where pollution can accumulate. Landscape features such as trees and vegetation in open spaces or as 'green' walls or roofs should be included.

Information should also be included in plans to indicate how structures such as buildings and other physical barriers will affect the distribution of air pollutants.

2. Development Management

NICE advises planners take action to reduce the number of motorised trips, supporting active travel, car clubs and the use of zero- and low-emission vehicles.

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[66] Kelly F and Fussell J, Air pollution and public health: emerging hazards and improved understanding of risk, Environmental Geochemistry and Health, August 2015, Volume 37, Issue 4, pp 631–649 https://link.springer.com/article/10.1007/s10653-015-9720-1#CR129

[67] Kelly F and Fussell J, Air pollution and public health: emerging hazards and improved understanding of risk, Environmental Geochemistry and Health, August 2015, Volume 37, Issue 4, pp 631–649 https://link.springer.com/article/10.1007/s10653-015-9720-1#CR129

[68] NICE, Air Pollution and Health, Guideline NG70, 2017

NICE also advises that Councils consider managing street trees and vegetation to reduce the risk of restricting street ventilation, where this may contribute to poor air quality (for instance, by the choice of species, siting and pruning regimes).

3. Clean Air Zones

NICE recommends considering the establishment of Clean Air Zones that include restrictions or charges on certain classes of vehicle and support zero- and low-emission travel, with aims to improve air quality across the whole zone in order to meet air quality guidelines. The guidance also suggests working across local authority boundaries to address regional air pollution and prevent migration of traffic and emissions to other communities.

To support zero- and low-emission travel, NICE recommends encouraging walking and cycling, as well as supporting uptake of zero- and low-emission vehicles, for instance by:

- providing more electric charging points
- encouraging use of these vehicles for deliveries
- Developing integrated public transport networks (including park-and-ride schemes) based on low-emission vehicles.

Other recommended actions to reduce emissions within Clean Air Zones include the introduction of fuel-efficient driving initiatives, bylaws to reduce idling where vulnerable groups congregate, driver training to reduce emissions, actions to smooth traffic flow, and action to minimise congestion caused by delivery schedules.

NICE also suggests that where traffic congestion is contributing to poor air quality, local authorities could consider incorporating a congestion charging zone within a clean air zone.

4. Reducing emissions from public sector transport services and vehicle fleets

In order to reduce the direct contribution of public sector transport to road emissions, NICE recommends that public sector bodies consider training and assessing their professional drivers to minimise vehicle emissions (for example, by reducing rapid accelerations and decelerations, optimising gear selection, maintaining recommended tyre pressure and switching off engines when parked). Technology and in-vehicle displays can support this and help with monitoring its success.

5. Smooth driving and speed reduction

As well as raising awareness among drivers, NICE recommends making changes to the roads to promote smooth driving. These include providing real-time information to drivers on optimum speeds and introducing 20mph limits. Where physical measures to reduce speeds are introduced to reduce harm from traffic collisions, NICE recommends design that helps maintain a steady reduced speed on roads.

6. Walking and cycling

Increasing the proportion of people choosing to walk and cycle would be one of the most impactful ways of reducing the public health damage caused by air pollution. Replacing a short car journey with a walk or a bike ride will reduce the number of cars on the road, lessen emissions from individual vehicles and reduce congestion so that overall air pollution is lower. It will also expose the person making the journey to less concentrated air pollution, especially if they are able to take a low-pollution route.

An additional benefit to public health is that walking and cycling are more active modes of transport than driving, which could help to increase the number of people who get enough physical activity. Physical inactivity has a much bigger negative impact on health in the UK than air pollution does, and research has shown that the benefits of outdoor physical activity are greater than the potential harms of exposure to air pollution, even for people with lung conditions.[69] According to research published in 2016, the health benefits of cycling and walking would far outweigh the harms of air pollution in 99% of world cities. Even in the most polluted city in Europe, it would be necessary to spend more than 13 hours per day walking before the harm from air pollution outweighed the benefits of physical activity.[70]

Figure 12: Ten indicators of a healthy street (Transport for London)

NICE has published separate guidelines on how to promote walking and cycling.[71] In its air quality guideline, it recommends supporting active travel, for example by providing a choice of less polluted cycle routes, maximising space between cyclists and motor vehicles and configuring junctions to minimise the time cyclists spend there.

Transport for London has also reviewed evidence on what works to promote walking and cycling, and used this evidence to develop its Healthy Streets Approach.[72] This identifies ten indicators of a healthy street which is conducive to active travel, improved air quality and better social interaction (Figure 12). Using local planning and transport powers to maximise these ten characteristics should improve public health in several ways.

7. Awareness raising

NICE recommends a number of activities to raise awareness of air pollution, how to reduce it and what to do to minimise its health impact. These include ensuring healthcare professionals are aware of what to do,

[69] Fisher et al, Physical Activity, Air Pollution, and the Risk of Asthma and Chronic Obstructive Pulmonary Disease, Am J Respir Crit Care Med. 2016 Oct 1;194(7):855-865 https://www.ncbi.nlm.nih.gov/pubmed/27653737
[70] Tainio et al, Can air pollution negate the health benefits of cycling and walking? Preventive Medicine Volume 87, June 2016, Pages 233-236 (see also https://www.theguardian.com/environment/2016/may/05/benefits-cycling-walking-outweigh-air-pollution-risk-cities, accessed January 2018)
[71] NICE, Physical Activity: Walking and Cycling, PH41, 2012, https://www.nice.org.uk/guidance/ph41 (accessed January 2018)
[72] Transport for London, Healthy Streets for London, 2016

and advising local businesses on how to reduce their impact on local air quality. For the public, NICE advises providing information on daily air quality, as well as information on its health impact and how to minimise air pollution and exposure to it.

Vulnerable groups

NICE advises that special consideration should be given to those at particular risk, including children, older people and people with chronic health problems. For most people, most of the time, pollution should not interfere with usual activities, and the health benefits of being active will usually be much greater than the harms of air pollution. However, NICE advises that vulnerable people should reduce strenuous physical activity outside on highly polluted days or at particularly congested locations, and keep windows and doors closed if they face highly congested streets.

The Daily Air Quality Index (table 3) gives advice from Public Health England and DEFRA on how to stay healthy on days with different levels of air pollution. [73]

Table 3: Daily Air Quality Index health advice for vulnerable groups and for the general population

Air Pollution Banding	Value	Accompanying health messages for at-risk individuals	Accompanying health messages for the general population
Low	**1-3**	**Enjoy** your usual outdoor activities.	**Enjoy** your usual outdoor activities.
Moderate	**4-6**	Adults and children with lung problems, and adults with heart problems, **who experience symptoms**, should **consider reducing** strenuous physical activity, particularly outdoors.	**Enjoy** your usual outdoor activities.
High	**7-9**	Adults and children with lung problems, and adults with heart problems, should **reduce** strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also **reduce** physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should **consider reducing** activity, particularly outdoors.
Very High	**10**	Adults and children with lung problems, adults with heart problems, and older people, should **avoid** strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	**Reduce** physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.

Efficient combustion and minimising other sources of air pollution

The second largest contributor to NO_2 pollution in Kingston is domestic and commercial combustion. Ensuring homes and other buildings are energy efficient, and keeping boilers well maintained would help to reduce emissions of pollutants from these sources, as well as potentially improving public health by reducing excess winter deaths related to cold weather.[74] It has also been shown that improving eco-design standards for wood burners would reduce their contribution to particulate pollution.[75]

[73] Daly Air Quality Index, Recommended Actions and Health Advice, https://uk-air.defra.gov.uk/air-pollution/daqi (accessed January 2018)
[74] E3G, Cold Homes and Excess Winter Deaths, 2018, https://www.e3g.org/docs/E3G_NEA_Cold_homes_and_excess_winter_deaths_2018.02.pdf
[75] http://ec.europa.eu/environment/air/pdf/TSAP-SMALL_SOURCES-20120612%5B1%5D.pdf (accessed January 2018)

Fireworks and bonfires can also affect local air quality significantly in the short term, and enforcement of regulations to control smoke are an important way to minimise the impact.

8. Current action on air quality

National and international action

Many air quality regulations, including vehicle emissions standards, are set by the European Union (EU) and it is currently unclear how this will change after the UK leaves the EU in 2019. The EU has issued an air quality directive setting standards for several pollutants that are harmful to the environment and to people's health and placing an obligation on national governments. These standards have been incorporated into English law by the Air Quality Standards Regulations. The UK objectives for pollutants are outlined in Table 4.

Table 4: UK objectives for pollutants

Pollutant	Objective (UK)	Averaging Period	Date[1]
Nitrogen dioxide NO_2	200 µg m^{-3} not to be exceeded more than 18 times a year	1 hour mean	31 Dec 2005
	40 µg m^{-3}	Annual mean	31 Dec 2005
Particles - PM_{10}	50 µg m^{-3} not to be exceeded more than 35 times a year	24 hour mean	31 Dec 2004
	40 µg m^{-3}	Annual mean	31 Dec 2004
Particles - $PM_{2.5}$	25 µg m^{-3}	Annual mean	2020
	Target of 15% reduction in concentration at urban background locations	3 year mean	Between 2010 and 2020
Sulphur Dioxide (SO_2)	266 µg m^{-3} not to be exceeded more than 35 times a year	15 minute mean	31 Dec 2005
	350 µg m^{-3} not to be exceeded more than 24 times a year	1 hour mean	31 Dec 2004
	125 µg m^{-3} mot to be exceeded more than 3 times a year	24 hour mean	31 Dec 2004

Note: [1]by which to be achieved by and maintained thereafter

The current overarching framework for UK policy on air pollution is the Air Quality Strategy (2007). Local authorities are required to annually "review and assess" the air quality within their area and work towards achieving compliance with Air Quality Standards by a specific deadline. Each local authority is required to submit an annual report providing details of the air quality within its area. Where an objective is not being met, or unlikely to be met, the local authority is required to declare an Air Quality Management Area (AQMA). This needs to cover the area or areas where the objectives are being exceeded as a minimum, but it can be wider.

The UK government acknowledges that there is a particular problem with management of NO_2 at roadsides. The latest UK plan for tackling roadside NO_2 was published in 2017 after significant legal action, and highlights a commitment to ending conventional car and van sales by 2040, along with existing funding initiatives to support lower vehicle emissions, public transport and local air quality schemes. A wider national Clean Air Strategy covering five key pollutants is planned during 2018.[76]

[76] DEFRA and Department for Transport, 2017, UK plan for tackling roadside nitrogen dioxide concentrations https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/633269/air-quality-plan-overview.pdf (accessed January 2018)

London action

As a London borough, Kingston is directly affected by Greater London Authority and Transport for London policies as well as by national policies. Draft versions of the Mayor's Transport Strategy, London Environment Strategy, London Health Inequalities Strategy and London Plan detail Mayoral plans which could affect air quality and public health across London, including in Kingston. Once the final strategies are published, individual boroughs will be responsible for most aspects of their local implementation, with funding through the Local Implementation Plan.

Health and health equity are central to these strategies, which include aims to create healthier streets by reducing emissions and road casualties, and developing London's cycle route network. The approach to development proposed by the London Plan is to concentrate development close to public transport hubs and minimise reliance on motor transport.

Key existing and planned air quality schemes in London include:

- **Congestion charge:** all vehicles entering the congestion zone incur a charge. Anecdotal evidence suggests that one unintended local effect is that heavy goods vehicles divert into New Malden High Street to avoid continuing along the A3 and into the charging zone.
- **T Charge:** the next evolution of the congestion charge, the T-change is an additional levy on older vehicles in central London which don't meet the latest emissions standards. It came into force in October 2017.
- **U-LEZ:** The ultra-low emission zone will be implemented in 2019, expanding to the North and South Circular boundary in 2021. Vehicles which exceed specified levels of emissions will be subject to daily charges.
- **Schools:** 50 air quality audits will take place at primary schools in areas exceeding legal limits of nitrogen dioxide in 24 London boroughs (NO_2) and these boroughs will work with schools to implement proposed changes with funding from the Mayor[77]. None of the 50 schools identified are in Kingston.
- **Low Emission Neighbourhoods:** five areas, spanning eight boroughs, have been identified for partnership work to improve local air quality.
- **Reducing emissions from buses:** TfL will be ensuring that buses operating in Central London are zero emission by 2020. In addition, ten low emission bus zones in areas of poor air quality outside central London were announced in 2017.[78]
- **Cleaner Vehicle Checker:** a website which enables Londoners to check the emission levels for vehicles they are considering buying.

London's support for local air quality management

Mayor's Air Quality Fund (MAQF): The MAQF is a £20m fund to support new projects by boroughs to improve air quality. Previous tranches of funding have paid for local projects in 28 boroughs including awareness-raising campaigns, electric vehicles, no idling campaigns and joint action with the NHS.[79]

[77] https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/cleaning-londons-air

[78] Greater London Authority, Sadiq Khan announces 10 new Low Emission Bus Zones to tackle toxic air, https://www.london.gov.uk/press-releases/mayoral/mayor-announces-10-new-low-emission-bus-zones (accessed January 2018)

[79] Mayor of London, Mayor's Air Quality Fund, Supporting Local action on Air Quality, 2016 https://www.london.gov.uk/sites/default/files/mayors_air_quality_fund_report_2016.pdf (accessed January 2018)

Kingston did not meet the requirements for funding in the previous round, but a new round of funding is expected to be announced in 2018.

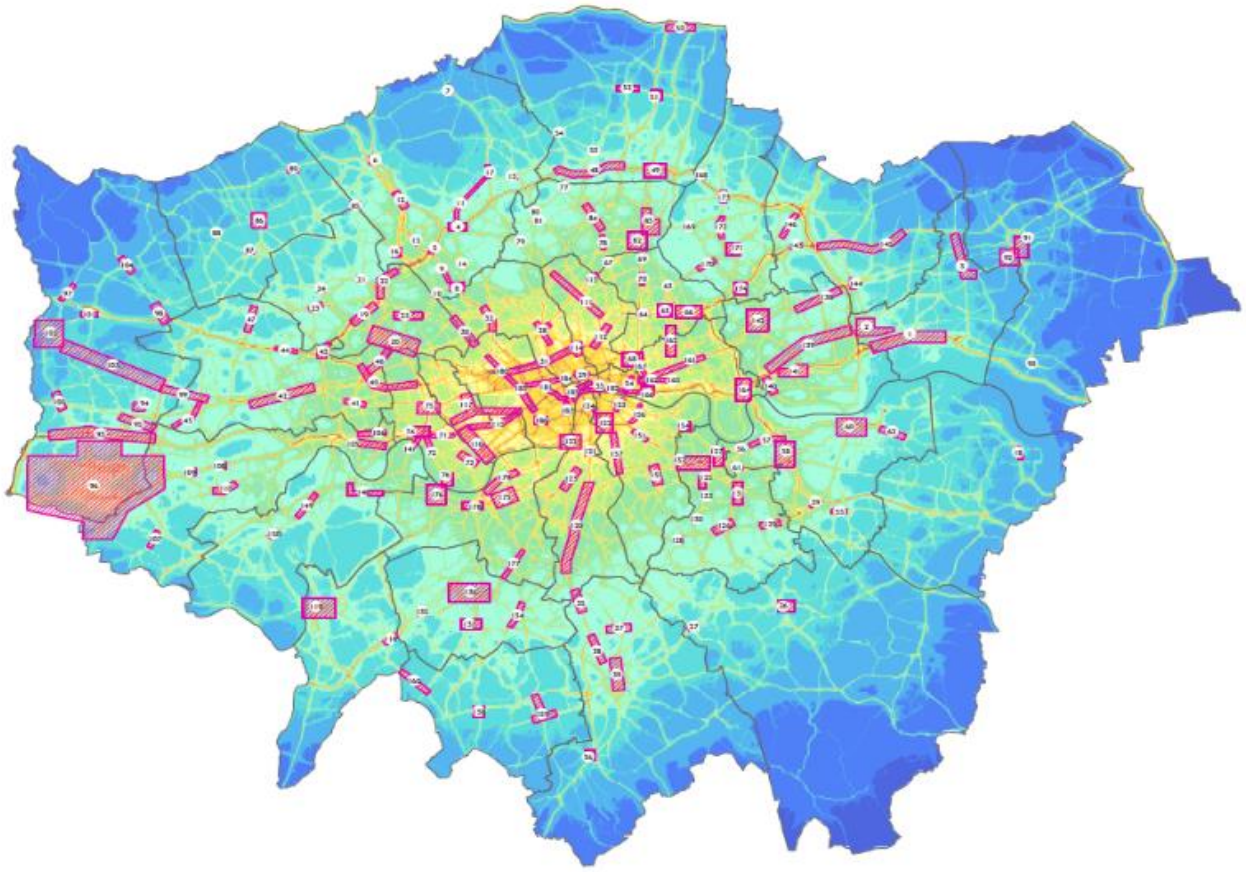
Focus areas

In 2013, 187 Air Quality Focus Areas were redefined across London in locations where the EU annual mean limit value for NO_2 was exceeded and there was high human exposure. These areas were selected through an analysis of the following factors:

- Baseline air quality for NO_2 and PM_{10} by 20m grid resolution
- Locations where air pollution limit values have been exceeded
- Level of human exposure
- Local geography and topography
- Local sources of air pollution
- Traffic patterns
- Future predicted air quality trends

These locations were not designed to be an exhaustive list of London's air pollution hotspots, but, rather where the problem was most acute. Under London Local Air Quality Management guidelines, boroughs have a duty to consider the focus areas in their borough when devising their air quality action plans. The Focus Areas have been used by the GLA (Greater London Authority), TfL (Transport for London) and the London boroughs to inform local air quality management, the development of air quality interventions and the planning process.

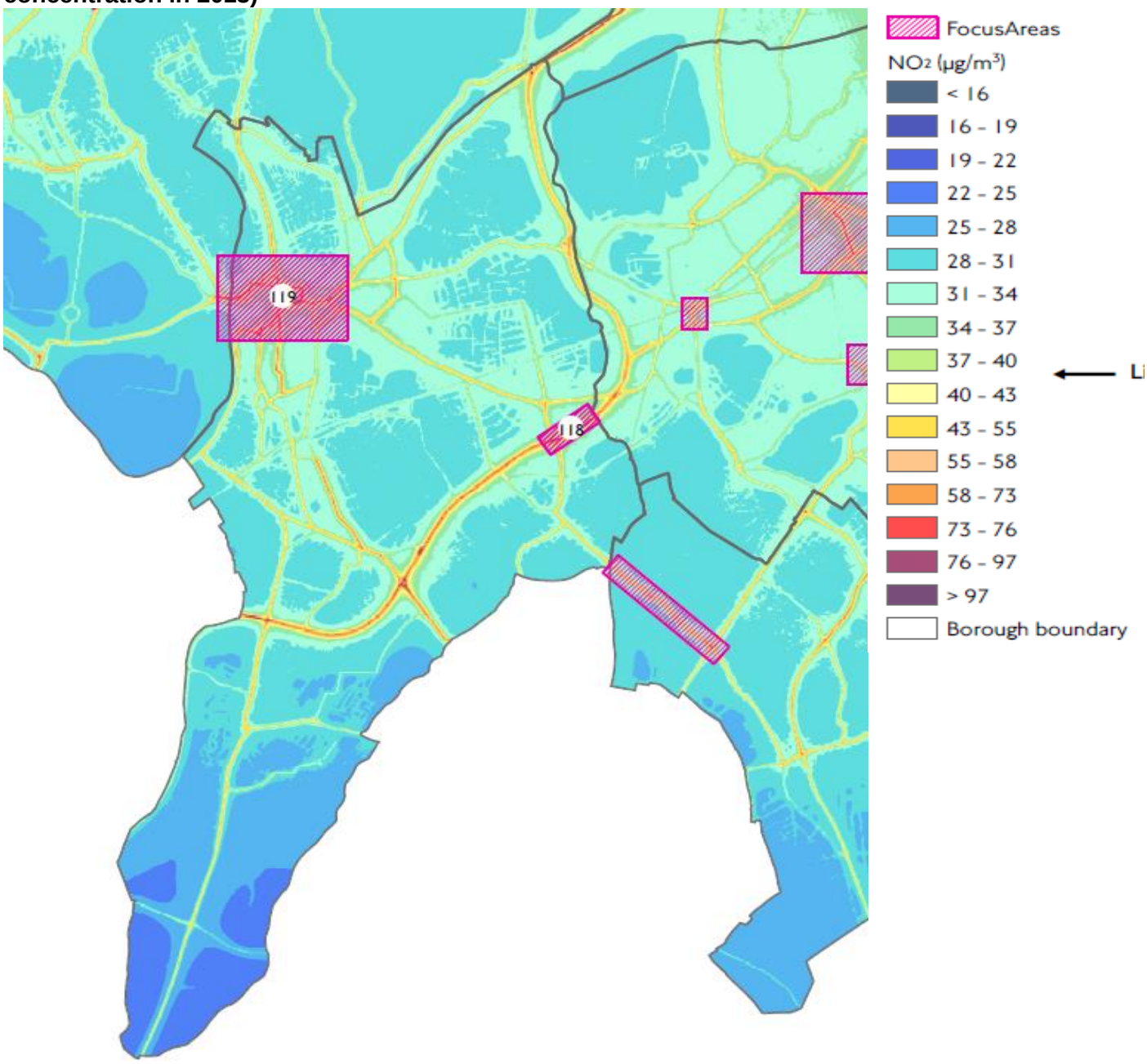
Figure 13: NO_x Emissions and Air Quality Focus Areas (red) in London Boroughs, LAEI 2013



Source: London Atmospheric Emission Inventory, 2013

Two of London's Focus Areas are in Kingston, one in Kingston town centre and one on the A3 at the Malden Junction.

Figure 14: Focus Areas in Kingston and surrounding areas (showing annual mean NO2 concentration in 2013)



Source: London Atmospheric Emission Inventory, 2013

Local action in Kingston

Kingston Council and its partners have several programmes in place to reduce emissions, as well as to promote things which may have a positive impact on air quality such as green spaces and trees.

In January 2003, the Royal Borough of Kingston upon Thames became an Air Quality Management Area (AQMA) for NO_2 and PM_{10}, requiring the Council to develop an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of National Air Quality Objectives. Since then, PM_{10} levels are now within the objectives, though some areas still do not meet required NO_2 levels.

Kingston's Air Quality Action Plan was most recently revised in 2016 and includes measures to be implemented by 2021. The Plan highlights the impact of motorised road traffic as a contributor to poor air quality and the majority of actions are aimed at reducing these emissions.

Kingston Council undertakes a number of activities that could be described as "business as usual" to improve air quality. These include:

- Integration of the Air Quality Action Plan within local development frameworks
- Ensuring that relevant developments undertake air quality impact assessments
- Undertaking regular air quality monitoring
- Regulation of industrial emissions through environmental permitting processes
- The enforcement of Clean Air Acts and Smoke Control Orders
- The provision of low emission (electric) vehicle power charging infrastructure throughout the borough
- Supporting cycling training in schools
- Supporting cycle and active travel infrastructure
- Leading by example and supporting and promoting car clubs by council staff.

Tackling air pollution requires a multiagency approach and the Council works across departments and with partners to achieve its Action Plan targets. Specific programmes include:

Active Travel

The active travel team works with partners and residents across the borough to increase active travel journeys. In 2016, 1,257 children were trained at Level 2 Bikeability and 271 reached Level 3; 97 Go Cycle events were held; and 1,010 free bike checks carried out. There were 102 referrals for the free bike loan scheme and 348 people engaged in Adult Cycle skills sessions. In 2015, Kingston upon Thames was recognised by the Transport for London (TfL) Education and Training Project Officer as a high performing Borough for Level 3.

The Sustainable Transport Team continues to support the following initiatives alongside the wider Go Cycle programme.

- Free cycle training
- Cycle information
- Bike maintenance courses
- Go Cycle events
- Free Dr Bike checks
- Free bike loan scheme
- Brompton bike hire dock at Surbiton station
- Increased bike parking
- School travel planning
- Safer urban driver training.

Kingston Go Cycle (formerly Mini-Holland) Programme

The Royal Borough of Kingston received an allocation of £30 million mini-Holland funding from TfL to implement the Go Cycle programme. This forms part of the Healthy Streets vision for London. As part of Go Cycle, Kingston is seeking to create new walking and cycling routes to improve road safety for everyone, upgrade public spaces and relieve the pressures on the borough's transport network. The objectives of the programme are to:

1. Substantially increase the amount of cycling in the borough
2. Transform the environment for cycling in the borough
3. Improve the level of satisfaction with cycling infrastructure
4. Provide a high quality, high capacity cycle network of interconnecting routes that form an identifiable core network
5. Encourage more cycling among 'hard to reach' groups
6. Improve safety for cyclists
7. Facilitate part-cycled commuter journeys
8. Reduce congestion and smooth the flow of traffic
9. Improve the quality of the public realm
10. Support the vitality and viability of our town, district and local centres.

The first infrastructure scheme within the programme provided a two-way cycle lane and revitalised the Queen's Promenade alongside Portsmouth Road. It was officially opened by London Deputy Mayor for Transport, Val Shawcross, and London Walking and Cycling Commissioner, Will Norman, in April 2017. Public consultation on the second wave of projects has been carried out and further construction works are underway.

Control of emissions from new developments

The impact on air quality from new developments is considered when planning permission is being sought, and the Pollution Control Team provides comment and advice on planning applications that have the potential to significantly impact on air quality. As the whole of the borough is an Air Quality Management Area, developers are required to submit an Air Quality Assessment with applications for developments that are likely to lead to an increase in concentrations of NO_2 and/or PM_{10}. Where appropriate, Kingston Council will request that an Air Quality assessment is carried out.

The Council is likely to request that an Air Quality Assessment is carried out and submitted with the application where one or more of the following applies:

- Developments comprising 10 or more residential units
- Developments covering an area of 1000m^2 or more
- Developments where there are sensitive receptors within 50m
- Developments that will introduce receptors into an area where air quality objectives are already being exceeded
- Developments that will result in a significant increase in vehicle movements e.g. a new supermarket.

When carrying out an Air Quality Assessment, the following should be considered by those submitting the application:

- The impacts on existing receptors during the demolition/construction phase
- The impacts on existing receptors once the development is occupied and operational

- The impacts on future occupants of the development from exposure to the predicted levels of air quality
- The cumulative impacts from other committed developments within the vicinity.

This could be an important element of the Council's work on air quality over the coming years, since major expansion of development is proposed for Kingston under the draft London Plan. Four areas have been identified as short term opportunity areas. They are:

- Kingston Town Centre
- Norbiton, London Road and Cambridge Estate
- New Malden
- Tolworth.

As identified in this assessment, there are significant existing problems with air quality in some of these areas.

Control of emissions from chimneys

The whole of the borough has been declared a Smoke Control Area. It is an offence under the Clean Air Act 1993 to allow dark smoke to be emitted from a chimney (or similar) within a Smoke Control Area. This applies to domestic properties as well as commercial and industrial premises. In practice, this means that it is an offence to burn most logs and coal in an open fireplace or other appliance that is not exempt.

Control of smoke from bonfires

The Council receives more complaints about bonfires than any other form of air pollution. The short term polluting effect of low level smoke can be considerable, particularly in built up areas, and bonfire smoke contains pollutants that can have damaging health effects.

It is an offence under the Clean Air Act 1993 to burn materials likely to give rise to dark smoke on commercial premises. Such materials include soft furnishings, carpet, rubber and treated wood. Regulations on the disposal of waste may also apply. Therefore, Kingston Council encourages businesses to have a contract in place for disposing of all waste that they cannot reuse or recycle.

The regulations do not apply to bonfires on domestic premises, so garden bonfires are permitted. Nevertheless, the Council is committed to improving air quality and therefore discourages this method of disposal of garden or other waste. Sustainable methods such as composting, shredding and recycling are encouraged, but where these methods are not suitable, the Council provides a green garden waste collection service.

In addition, subject to certain exemptions, the Council is able to take action where pollutants originating from any premises are found to be prejudicial to health or a statutory nuisance. Kingston Council is able to take formal action under the Environmental Protection Act 1990 when burning of garden waste is a regular occurrence and a statutory nuisance is caused. Individuals can be liable for a fine of up to £5,000.

Air Pollution Alerts and communication

AirText is a free service that alerts subscribers to the air quality forecast for the coming three days when air pollution levels are predicted to be higher. The service is available to all, but is particularly intended to be useful for those who suffer from conditions such as asthma, COPD, angina, and those affecting the cardio-respiratory system and their carers so that precautions can be taken. As well as air quality this

service also provides information on UV and pollen. Hourly updates can be found on the London air website[80].

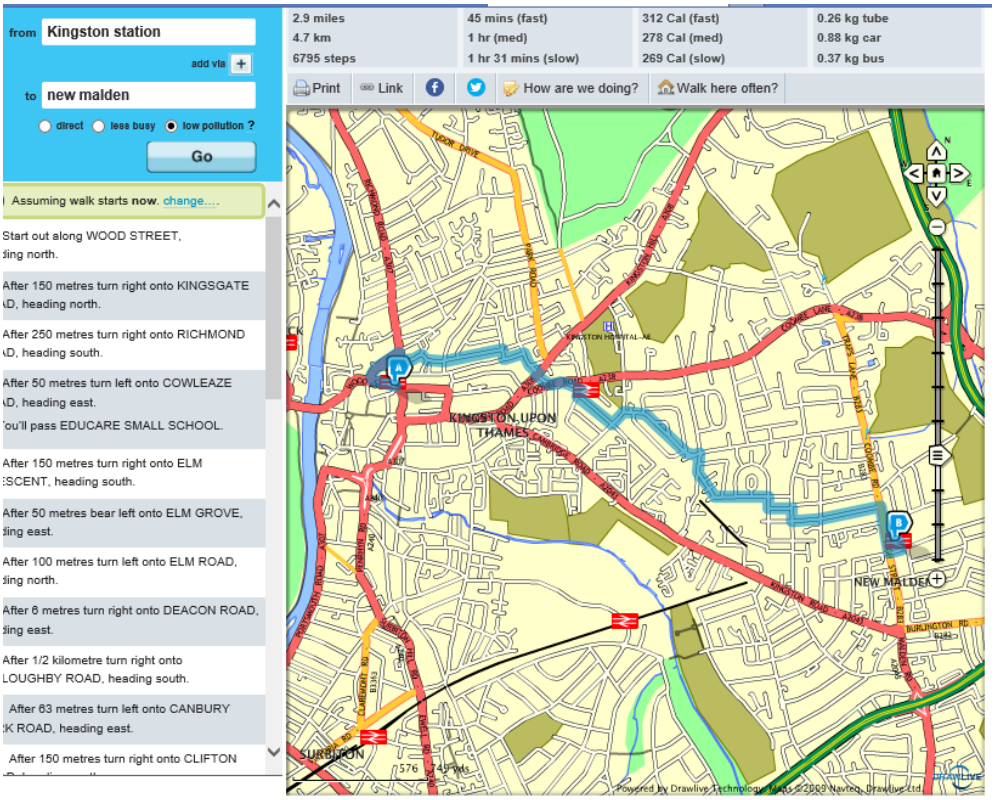
Alongside the AirText service, Kingston Council is developing a protocol for the dissemination of information on air pollution when poor air quality events are predicted. This will ensure everyone who lives, works or spends time in Kingston is able to stay up to date with air quality information and how to respond to it.

Low Pollution Walking Routes

As well as providing exercise, walking instead of travelling by motor vehicle helps to reduce levels of air pollution. A walking route can be planned using a journey planner which can show the most direct route as well as the route where the air pollution levels are the lowest using walkit.com.

This site is also available as a phone app and provides information on calories burned, CO_2 saved as well as showing the hill profile for the route chosen. An example journey is shown in Figure 15.

Figure 15: Low pollution walking route in Kingston



Kingston Beat the Street

Kingston Council is seeking funding to deliver a Beat the Street project across the whole of the borough. Beat the Street empowers communities to increase physical activity and improve health. It's a 12-month programme with an inclusive, simple game at its heart which gets the young, the elderly, the inactive and those with long-term conditions moving together – embedding long-term health benefits across a community. The programme uses advanced smart-card and online technology to run a walking and cycling competition that captures imagination and acts as a catalyst to create a social norm around moving more.

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[80] http://www.londonair.org.uk/
https://www.london.gov.uk/sites/default/files/draft_environment_strategy_-_executive_summary.pdf

The game is fun and engaging for all age groups. Its principles are to keep the community and particularly the primary schools at the heart, connect people to each other, their community and to nature, empower the community to continue to be active once the game has come to an end, encourage more people to volunteer and improve activity, well-being, community cohesion, health and resilience. The environmental impact is to reduce emissions and improve air quality as more people leaving their cars at home, particularly during the school run, would reduce emissions and improve air quality.

Kingston University

Kingston University has undertaken work to improve sustainable transport and has received funding to update their inter-site bus service to hybrid models as part of the Department of Transport's Low Emissions Bus Service programme. In response to student demand and with the critical financial backing of the Board of Governors and senior management, Kingston University introduced a new hybrid bus service in September 2016. The seven hybrid buses have since provided 942,000 passenger trips and travelled over 246,000 miles. The hybrid fleet has saved over 60,000 litres of fuel, over 158 tonnes of CO2 emissions – around a third less than standard buses. It has reduced NOx emissions by 92% and PM10 emissions by 96%, saving 503kg of harmful NOx and 15kg of highly dangerous PM10 from entering into the local environment.

The university works closely with the Kingston Go Cycle project and is part of a national pilot project (run through the Environmental Association for Universities and College and NUS) aiming to shift from car to bicycle use. The University also offers a point-to-point e-bike hire scheme to enable students and staff to travel between campuses.

Environmental permits

Some industrial processes have the potential to cause pollution and these processes must have a permit to operate. There are currently three types of processes:

- Part A1 processes, which have the potential to cause pollution and are regulated by the Environment Agency (these include major waste operations)
- Part A2 processes, which have the potential to cause pollution and are regulated by local authorities (examples include non-hazardous or animal waste incineration and certain types of manufacturing)
- Part B processes, which have the potential to cause only air pollution and are inspected and regulated by local authorities (examples include vehicle re-spraying, dry cleaning and the unloading/delivery of petrol).

The Council is responsible for authorising and inspecting all Part B processes within the borough. This regime is also referred to as Local Authority Pollution Prevention and Control (LAPPC). All holders of an Environmental Permit are required to pay an annual fee known as a subsistence fee. These fees are set each year by DEFRA.

Kingston currently has 31 Part B permits and there is little variation from year to year.

9. Recommendations

Unless otherwise stated, all of the following are recommended for implementation within the lifespan of the current Kingston Air Quality Action Plan for 2016-21. Several recommendations have been made for local residents and organisations outside Kingston Council. In all of these cases, the Council should also support implementation through its own actions and policies.

The Greater London Authority and Transport for London should…

1. Work with the Royal Borough of Kingston to ensure London-wide air quality schemes can have a positive impact in Kingston
2. Consider developing mitigation plans to reduce the air quality impact in Outer London boroughs of high-polluting traffic diverted away from the Congestion Charge zone and U-LEZ
3. Work with the Royal Borough of Kingston to improve air quality on TfL-controlled roads.

Kingston Council's Highways and Transport team should…

4. Continue to develop the Go Cycle Kingston scheme and improve the walking and cycle network, focusing on increasing the proportion of people who walk as well as the proportion who cycle
5. Implement systematic local monitoring of the success of active travel initiatives
6. Consider focusing efforts to promote walking and cycling on journeys that contribute significantly to congestion, particularly journeys to and from school and work
7. Consider seeking additional grants and funding resources for walking and cycling initiatives at a local level, working in partnership with neighbouring boroughs to ensure plans and networks are coordinated across the area
8. Invest Local Implementation Plan funds for the Mayor's Transport Strategy in schemes designed to create Healthy Streets and make Kingston more walkable
9. Offer education and advice to public sector drivers about safe, fuel efficient driving and avoidance of engine idling
10. Consider extension of 20mph speed limits to regulate speeds.

Kingston Council's Strategic Planning team should…

11. Embed health improvement and reduction of health inequalities as key underpinning principles for the forthcoming Local Plan 2019 – 2041
12. Identify ways to minimise the impact of new developments on traffic in the borough, particularly in areas which have been identified for growth and which already have poor air quality.
13. Consider how to ensure major new developments undertake good quality health and health inequalities impact assessments, including assessment of air quality impact before, during and after the work is undertaken
14. Avoid siting facilities that are used by vulnerable groups near to major roads. This includes homes, schools, care homes and childcare settings.
15. Develop a policy for consideration in the Local Plan to limit access to Controlled Parking Zone permits for new developments.

Kingston Council's Parking team should …

16. In consultation with residents, consider introducing restrictions to discourage neighbouring area commuters from worsening congestion by driving into the borough to park
17. Consider introducing restrictions (such as higher parking charges) for highly polluting diesel vehicles in areas of poor air quality.

Kingston Council's Public Health team should…

18. Support improvement of air quality through the Healthy Schools programme by promoting walking and cycling and enabling schools to carry out their own air quality projects and local assessments
19. Work with colleagues across the Council to ensure health and air quality are represented in future strategies and implementation plans such as the Green Spaces strategy, as well as the Air Quality Action Plan

20. Support the assessment of the public health impacts of the Air Quality Action Plan and Go Cycle programme
21. Promote tools which help people to plan low pollution active travel routes (such as walkit.com).

Kingston Council's Environmental Health team should…

22. Ensure the criteria for Cleaner Air Borough status are met in order to ensure eligibility for funding from the Mayor's Air Quality Fund in 2018, and work with the Active Travel and Public Health teams to develop proposals to bid for funding
23. Review implementation of the Air Quality Action Plan in light of NICE guidance and this JSNA chapter
24. Work with the Public Health team to ensure vulnerable people receive timely information about the impact of air pollution on health, and how to respond to short term episodes of poor air quality, including via free air quality text alerts from AirText
25. Work with other Council departments to ensure fleet and contractor procurement considers environmental and air quality implications, including requirements to meet Euro VI standards
26. Review how best to ensure compliance with engine idling restrictions, and implement the best approach to reduce idling at key locations and times
27. Consider long-term funding options to ensure construction sites work within appropriate standards
28. Further investigate the local impact of wood burning.

Healthcare commissioners and providers in Kingston should…

29. Help staff, service users and visitors to walk, cycle or use public transport through improving accessibility, supporting staff to live locally and promoting active travel
30. Make sure staff know the health effects of air pollution and what advice to give to people who are concerned that they might be affected by air pollution
31. Minimise emissions from transport and deliveries through consolidation, reducing engine idling, driver training and ensuring vehicles meet the latest emissions standards.

Local developers should…

32. Consider conducting air quality health and health inequalities impact assessments for major new developments, making use of the London Healthy Urban Development Unit impact tool
33. Consider measures to reduce engine idling at construction sites
34. Identify and implement appropriate mitigation measures to reduce the impact of construction on local air quality. This includes dust mitigation and transport planning.
35. Identify and implement appropriate mitigation measures to reduce the impact of new developments on the health of residents. This includes following appropriate design standards for homes near to high pollution areas, minimising the contribution of all new developments to local motor traffic and supporting lower emission vehicles through offering electric vehicle charging points.

Local residents should…

36. Try walking or cycling short journeys, instead of driving
37. Ensure their home is well insulated and that they have a modern, well-maintained boiler with low NO_x emissions
38. Consider signing up for AirText and knowing whether they need to change their activities on high pollution days
39. Consider the air quality impact and review the GLA's Cleaner Vehicle Checker before buying a new car.
40. Consider the air quality impact and check the latest standards and regulations before buying a wood- or coal-burning stove.

Local businesses and employers should…

41. Consider freight consolidation schemes and scheduling changes to minimise congestion from deliveries

42. Consider supporting and encouraging staff and customers to walk or cycle. Employers might wish to offer Cycle to Work vouchers, cycle parking and showers, and to participate in initiatives like Walk to Work Week.
43. Discourage engine idling amongst their drivers and suppliers.

Local early years settings, schools, colleges and universities should…

44. Support walking and cycling to increase physical activity and minimise congestion. Primary schools might wish to support initiatives like Park and Stride, Walk to School badges and Walk to School Week.
45. Consider making active travel a key element of their individual Healthy Schools or Healthy Early Years programme.
46. Consider educating children about air pollution and its health effects, for example through running a local school air quality audit.
47. Continue to improve and build on cycling schemes for students and staff.

Appendix A: Sources and impacts of key pollutants

Pollutant	Consequences
Nitrogen Dioxide (NO_2) and Oxides of Nitrogen (NO_x)	Exposure to NO_2 can decrease lung function and increase a person's susceptibility to allergens and affect asthmatics.
	Nitrogen oxides in the atmosphere can be deposited into fresh waters and land, thus causing nutrient enrichment (eutrophication), and a reduction in biodiversity in sensitive ecological sites (such as RAMSAR sites, Special Areas of Conservation and Special Protection Areas).
	NO_x can react with other pollutants to form chemicals toxic to the environment such as ozone and other oxidising agents.
	NO_x emissions are also a precursor to secondary particles in the atmosphere.
PM_{10}	There have been numerous studies that associate PM_{10} with cardiovascular morbidity and mortality, and there would be health benefits of reducing PM_{10} concentrations below the current EU limit value.
	However, it appears that much, but not all, of the effects are due to the smaller fraction ($PM_{2.5}$).
	There is also evidence that short-term exposure to coarse particles (including crustal material) is associated with adverse respiratory and cardiovascular health effects, including premature mortality.
$PM_{2.5}$	$PM_{2.5}$ can reach the deepest (alveolar) portions of the lungs where gas exchange occurs between the air and the blood stream.
	Long term exposure to $PM_{2.5}$ can cause premature death, especially related to heart disease, and cardiovascular effects such as heart attacks and strokes.
	It is also linked to reduced lung development as well as the development of chronic respiratory diseases, such as asthma, in children. Some studies also suggest that long-term exposures to $PM_{2.5}$ may be linked to cancer and to harmful developmental and reproductive effects, such as infant mortality and low birth weight.
	Short-term exposure to $PM_{2.5}$ can exacerbate asthma and other respiratory symptoms, such as coughing, wheezing and shortness of breath.
	Black carbon, a significant component of $PM_{2.5}$ is a powerful climate change agent, but has a shorter atmospheric life than CO_2.
	Therefore the impact on climate of reducing black carbon emissions will occur quicker than efforts to reduce CO_2 emissions.
SO_2	SO_2 has an irritant effect on the lining of the airways (nose, throat and lungs) and can cause coughing, tightness in the chest and narrowing of the airways, reducing the flow of air to the lungs.
	People suffering from asthma are also more sensitive.
	SO_2 is oxidised in the atmosphere to form acid rain which can damage freshwater environments, soils and vegetation.
	SO_2 is also a precursor to secondary inorganic particles.

Source: "Clearing the air", The Chartered Institution of Water and Environmental Management

Appendix B: London Atmospheric Emissions Inventory background and projections for Kingston upon Thames

Air quality monitoring data can be used in modelling software to estimate the concentrations across the whole of the borough for future years. The Greater London Authority has produced the London Atmospheric Emission Inventory (LAEI) to show annual mean concentrations for nitrogen dioxide in 2013 and the projected levels for 2030. The LAEI is a database of geographically referenced datasets of pollutant emissions and sources in Greater London. The base year for the current LAEI is 2013, with back projections to 2008 and 2010, and forward projections to 2020, 2025 and 2030.

The LAEI 2013 includes the following key pollutant emissions:
• Nitrogen oxides (NOx);
• Particulate matter with aerodynamic diameter < 10 µm (PM10);
• Particulate matter with aerodynamic diameter < 2.5 µm (PM2.5); and
• Carbon dioxide (CO2).

Additionally, the LAEI includes a number of subsidiary pollutants:
• Sulphur Dioxide (SO2);
• Non Methane Volatile Organic Compounds (NMVOC);
• Benzene (C6H6) and 1, 3-butadiene (C4H6) (which are part of NMVOCs);
• Methane (CH4);
• Ammonia (NH3);
• Carbon Monoxide (CO);
• Nitrous Oxide (N2O);
• Heavy Metals Cadmium (Cd), Mercury (Hg) and Lead (Pb);
• Benzo[a]pyrene (BaP);
• PolyChlorinated Biphenyl (PCB); and
• Hydrogen Chloride (HCl)

The data presented in the maps below provides an evidence base of quantified exposure to air pollution across the whole population and the level of inequalities that exist within this pattern of exposure. Understanding in detail the spatial nature of such inequalities is important in the development of policies to reduce inequalities and in the wider context of sustainable development.

The pollution maps for 2013 and projected pollution maps for 2020 from LAEI have been used to quantify estimates of the population exposed to the levels of NO_2 pollution that exceeds EU Air Quality Directive limit value of 40 µg/m^3. Figure C1 shows that in 2013, 5.82% of the area in Kingston has NO_2 concentration levels above the EU limit. It also shows that exposure is expected to significantly decline after 2013 with a prediction that nearly no exceedance of the NO_2 limit value will occur by 2020.

Figure C1, C2, C4 and C6 highlight the fact that there is a geographical variability in pollution level within Kingston and not all dwellings will be directly exposed to concentration above the limit value. Whilst many dwellings avoid exposure to above the limit value there are some small areas, most of them close to road networks with high traffic flows and/or regular congestion, that are exposed and within people's daily activities it is assumed that they will be in close proximity to concentrations above the limit value if the average exceeds. When dwellings are situated back from the roads or in quiet streets, there is compliance with the air quality objectives. The areas of non-compliance are projected to significantly reduce in future.

It should be noted that these are modelled projections and there are significant uncertainties associated with future emission estimates, primarily due to the sensitivity of the concentration estimates to changes in base year meteorology (2013) and uncertainty of COPERT road transport emission factors, which have since been updated. The future emission modelling is likely to be updated in 2017 to take these changes into account and to consider the impact of planned policies.

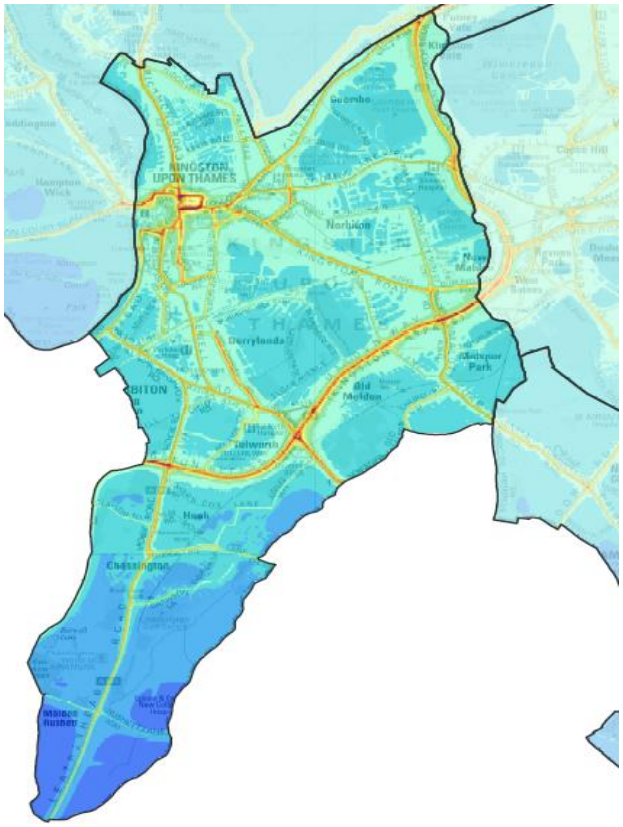
Reduction in particle emission over recent years have resulted in annual average concentrations of PM_{10} in Kingston reducing and now they are close to complying with EU PM_{10} limit values. Slight further reductions in annual average PM_{10} concentrations are expected between 2013 and 2020, however slightly higher concentrations will continue to occur in the vicinity of the arterial road network of Kingston (Figure 10). The World Health Organisation (WHO) has set an Air Quality Guideline concentration of 20 µg/m^3 as an annual mean for $PM_{10.}$

Currently, there are no legal limit value objectives in England for $PM_{2.5.}$ Figure 12 compares the $PM_{2.5}$ concentrations in Kingston in 2013 and 2020 to the current WHO Air Quality Guideline value of 10 µg/$m^{3.}$ The LAEI maps show that in 2030, $PM_{2.5}$ concentrations (<12 µg/m^3) are predicted to remain slightly above the WHO guideline value.

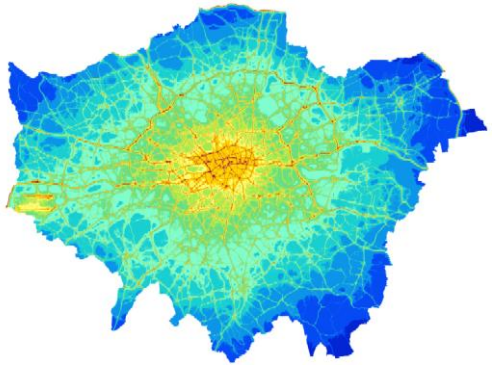
While the evidence shows that the health effects of exposure to PM are more severe, annual average of NO_2 concentrations provides a better metric for the assessment of differences in exposure to air pollution.

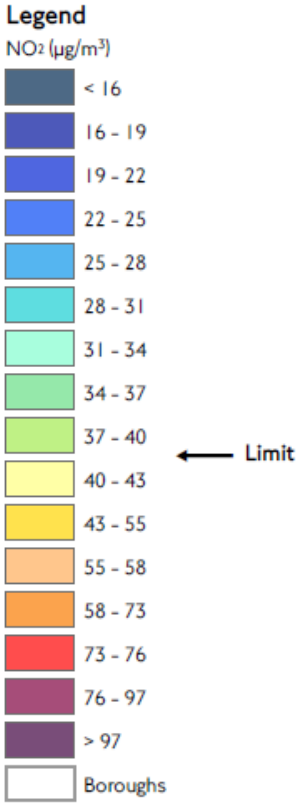
Figure B1: Annual Mean NO_2 concentrations for 2013 (baseline) & 2020 (projection)

2013



London inset



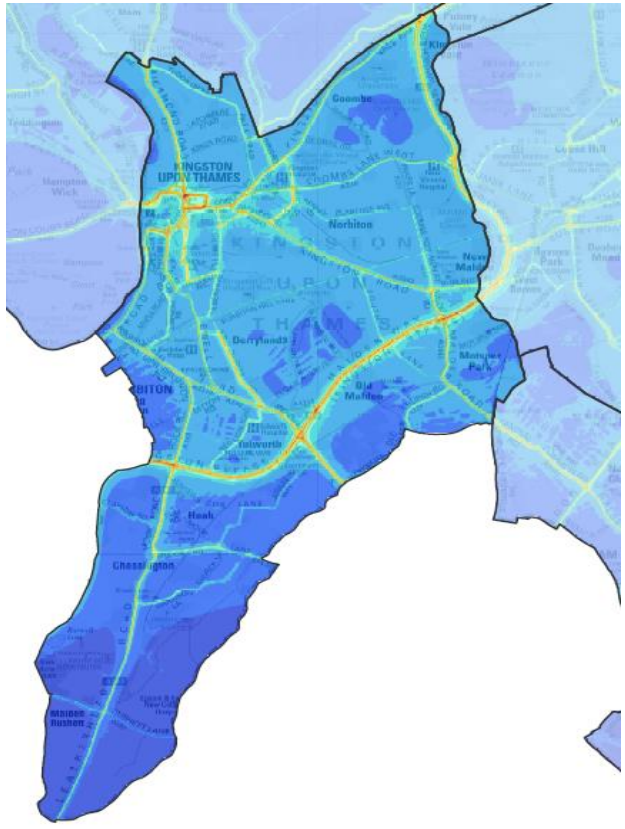


NO_2 Concentrations in 2013 and 2020

	2013	2020
Total Area	37.25Km^2	
Area > 40µg/m^3	2.17 Km^2	0.89 Km^2
Percentage > 40µg/m^3	5.82%	2.38%
Area > 60µg/m^3	0.32 Km^2	0.08 Km^2
Percentage > 60µg/m^3	0.87%	0.21%

Source: Greater London Authority, 2017

2020



London inset

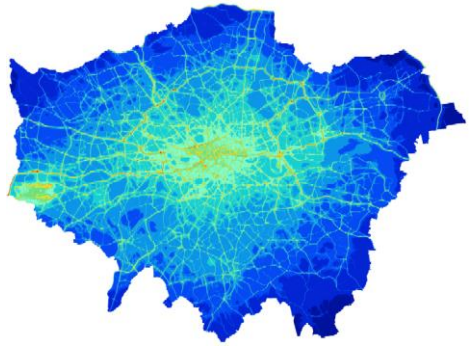
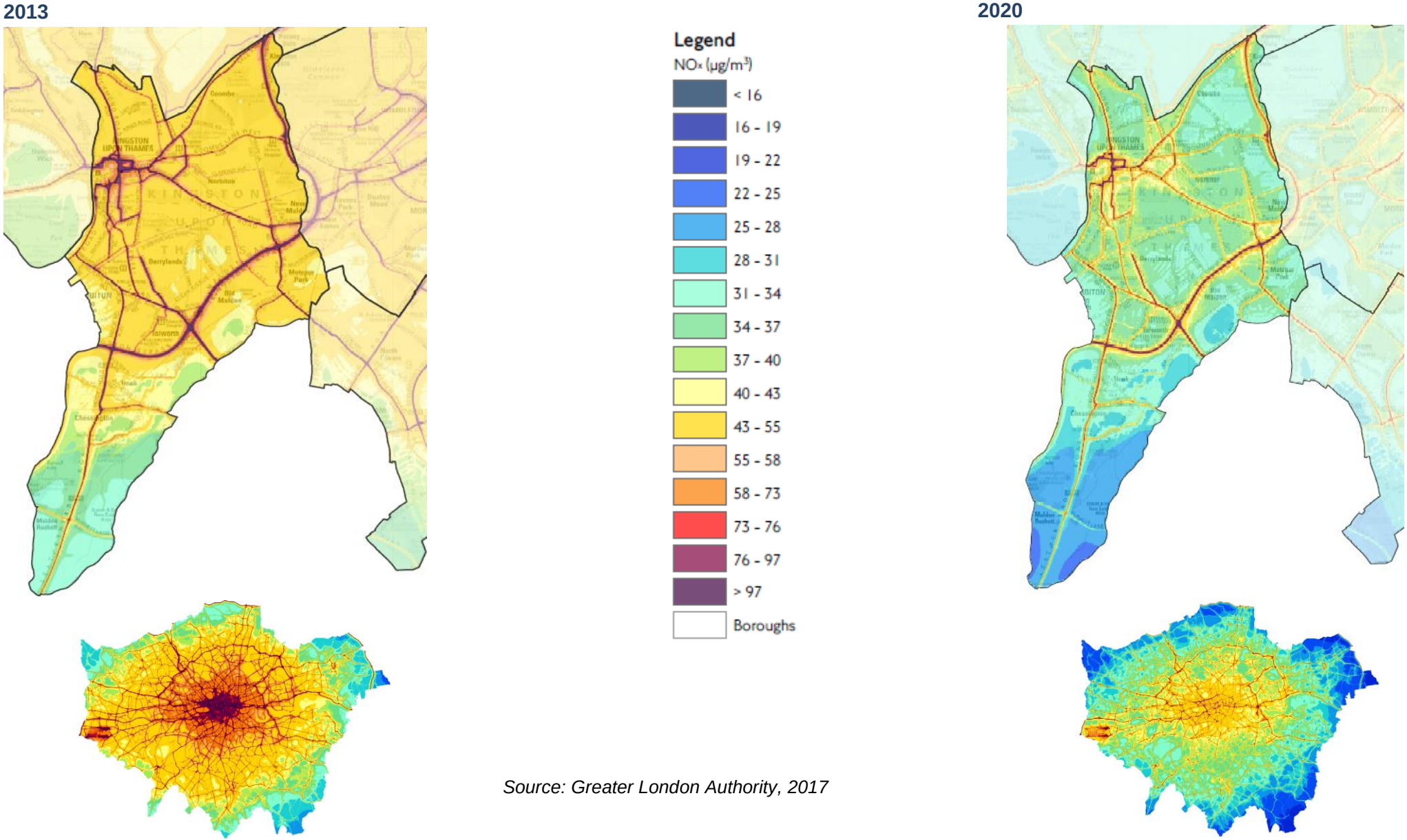


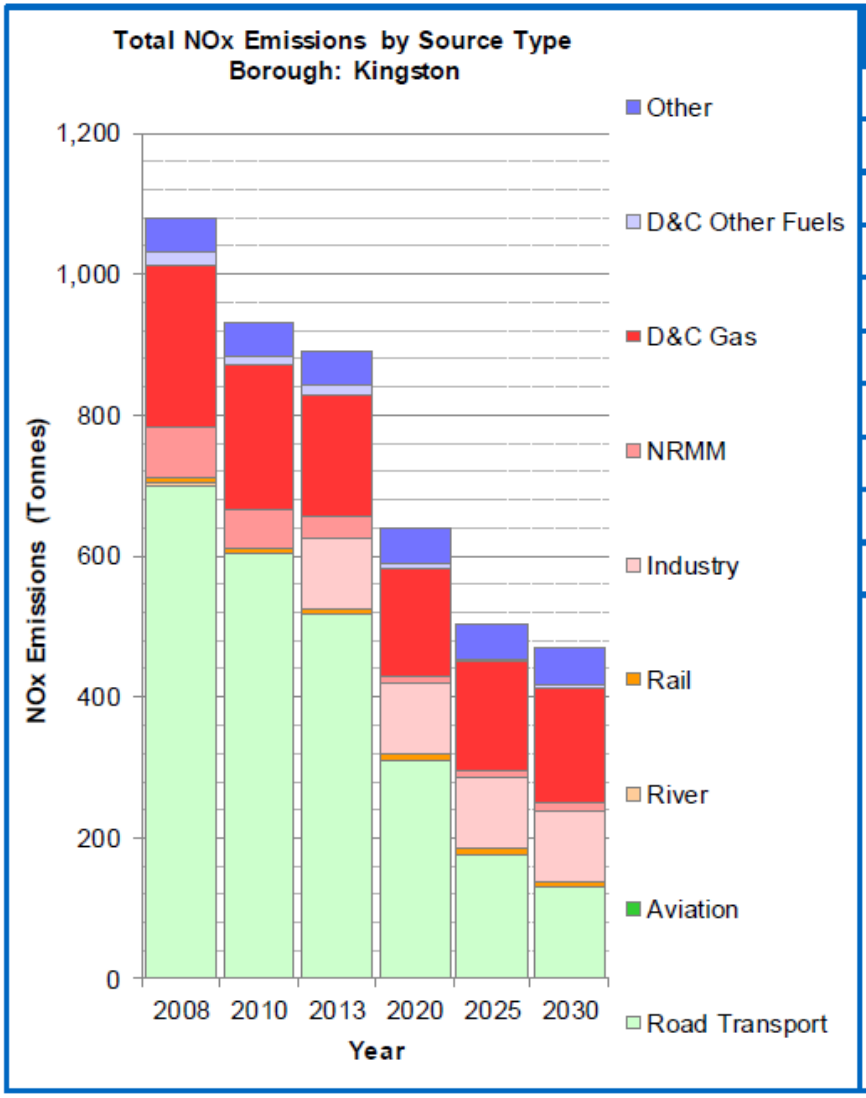
Figure B2: Annual Mean NO_X concentrations for 2013 (baseline) & 2020 (projection)



Source: Greater London Authority, 2017

NOx emissions for Kingston compare favourably against those present in London and surrounding boroughs. There is a prediction that over future years the emissions will improve overall (subject to current recommendations and actions being undertaken). Emissions are likely to increase from certain sources due to changes in technology and energy production, with predictions showing small increases in ‘Other’ and domestic and commercial gas use.

Figure B3: LAEI NOx emission dashboard for Kingston (2013 baseline with past and future projections)



Emissions (Tonnes) by	2008	2010	2013	2020	2025	2030
Road Transport	702	603	516	310	177	128
Aviation	0	0	0	0	0	0
River	0	1	1	1	1	1
Rail	8	8	8	8	8	8
Industry	1	1	100	100	100	100
NRMM	73	54	31	11	11	11
D&C Gas	229	203	173	153	151	165
D&C Other Fuels	18	14	13	5	4	3
Other	49	48	49	51	50	54
Total	1,080	932	891	639	502	470

Notes:

(D&C = Domestic and Commercial)

The summary graph represents emissions from each source stacked on top of one another, with the total stack height equalling the total emissions from all sources.

The numbers in the table are those used to plot the graph and represent the tonnes of pollution emitted into the atmosphere in that year (T/y).

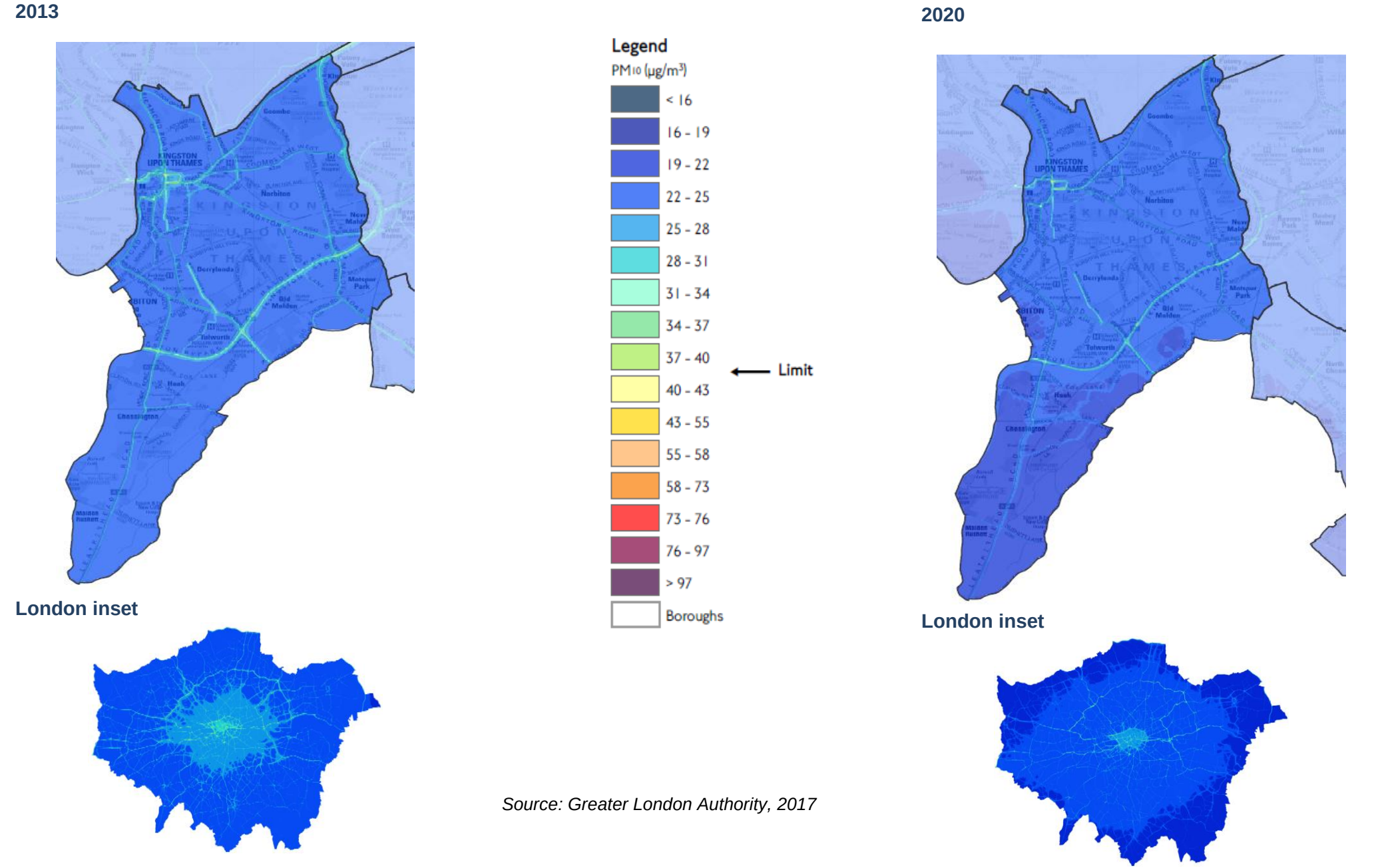
The emissions are combined into reasonably self explanatory "Source Types".

However, the categories: "Industry", "NRMM" and "Other" require further explanation:

- **Industry:** is the total emission from Part A and Part B industrial processes, combined.
- **Non-Road Mobile Machinery (NRMM):** is the total emissions from construction and industrial off road machines, combined.
- **Other:** is the total emission from a number of small sources including: agriculture, outdoor fires, garden emissions, forests, waste and waste transfer sites, combined.

Source: Greater London Authority, 2017

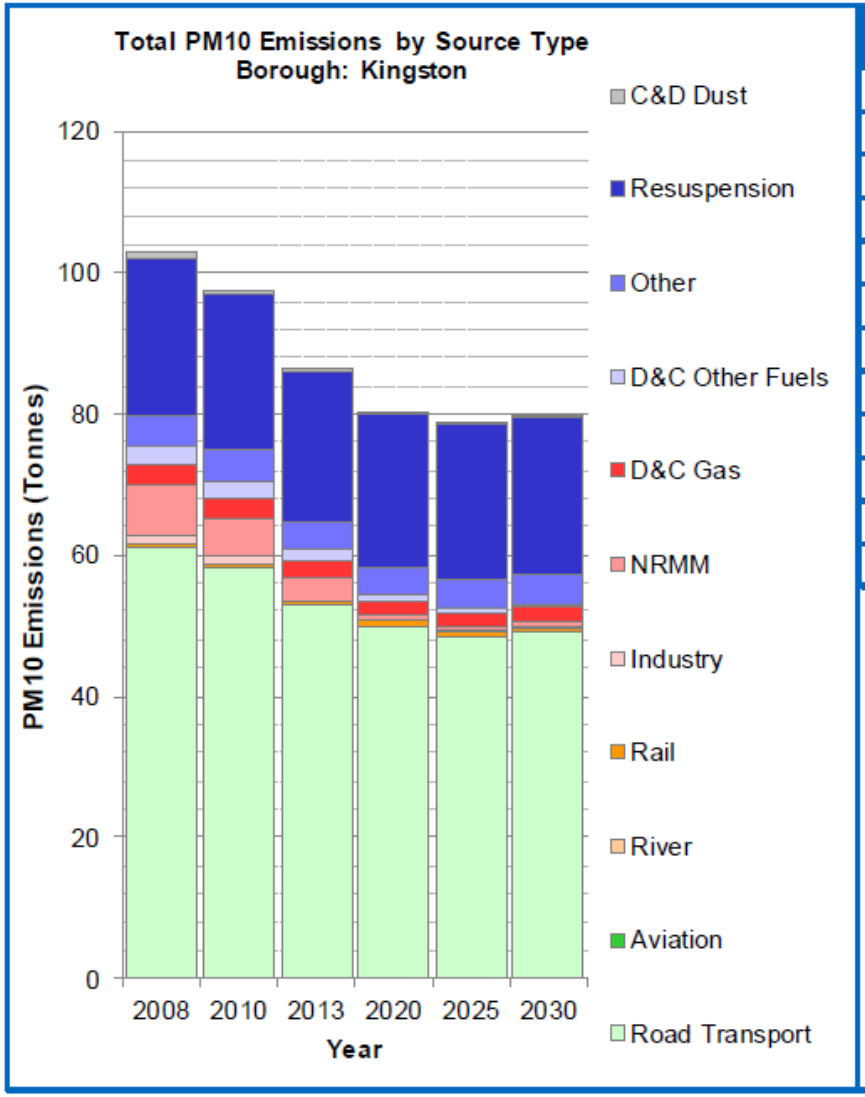
Figure B4: Annual Mean PM_{10} concentrations for 2013 (baseline) & 2020 (projection)



Source: Greater London Authority, 2017

PM_{10} emissions for Kingston compare favourably against those present in London and surrounding boroughs. There is a prediction that over future years the emissions will improve (subject to current recommendations and actions being undertaken) overall and current predictions are for the greatest reductions to occur in regard to road transport and Non-Road mobile Machinery. As predicted with NO_x, emissions are likely to increase from certain sources due to changes to practices, with predictions showing small increases in 'Other' and a larger increase in emissions from resuspension (dust being 're-suspended' in the air by the movement or actions of vehicles).

Figure B5: LAEI PM10 emission dashboard for Kingston (2013 baseline and past and future projections)



Emissions (Tonnes) by	2008	2010	2013	2020	2025	2030
Road Transport	61.0	58.2	52.9	50.0	48.4	49.1
Aviation	0.0	0.0	0.0	0.0	0.0	0.0
River	0.0	0.0	0.0	0.0	0.0	0.0
Rail	0.6	0.6	0.6	0.6	0.6	0.6
Industry	1.0	1.0	0.1	0.1	0.1	0.1
NRMM	7.3	5.5	3.1	0.7	0.7	0.7
D&C Gas	2.8	2.6	2.3	2.0	2.0	2.1
D&C Other Fuels	2.8	2.6	1.8	0.8	0.5	0.3
Other	4.3	4.5	3.7	4.0	4.2	4.3
Resuspension	22.3	22.0	21.2	21.7	22.0	22.3
C&D Dust	0.6	0.6	0.6	0.3	0.3	0.3
Total	102.8	97.6	86.3	80.3	78.9	79.9

Notes:

(D&C = Domestic and Commercial – C&D = Construction and Demolition)

The summary graph represents emissions from each source stacked on top of one another, with the total stack height equalling the total emissions from all sources.

The numbers in the table are those used to plot the graph and represent the tonnes of pollution emitted into the atmosphere in that year (T/y).

The emissions are combined into reasonably self explanatory "Source Types".

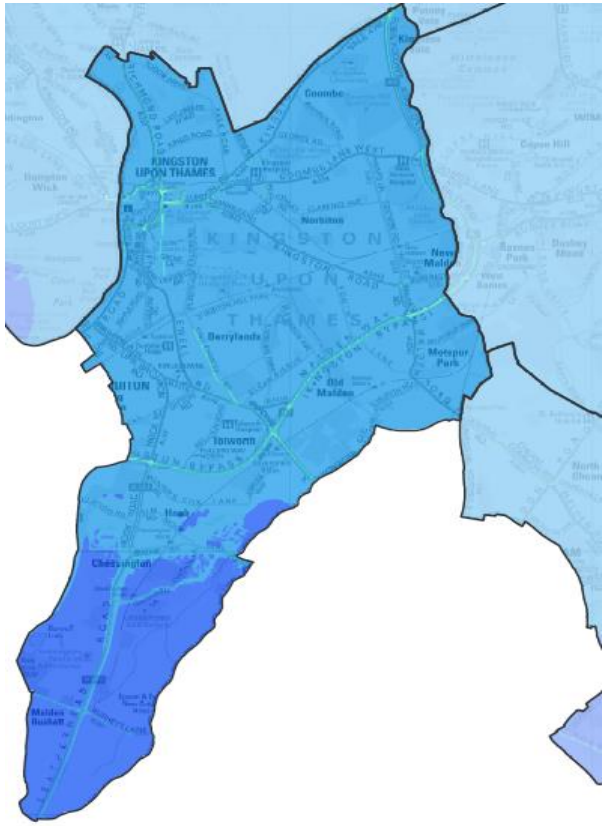
However, the categories: "Industry", "NRMM" and "Other" require further explanation:

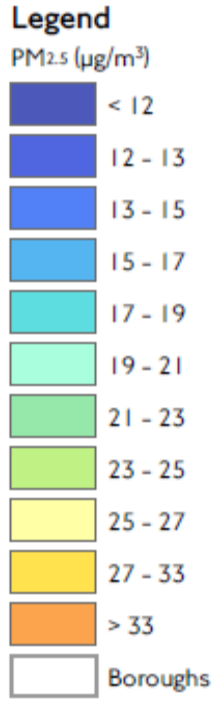
- **Industry:** is the total emission from Part A and Part B industrial processes, combined.
- **Non-Road Mobile Machinery (NRMM):** is the total emissions from construction and industrial off road machines, combined.
- **Other:** is the total emission from a number of small sources including: agriculture, outdoor fires, garden emissions, forests, waste and waste transfer sites, combined.

Source: Greater London Authority, 2017

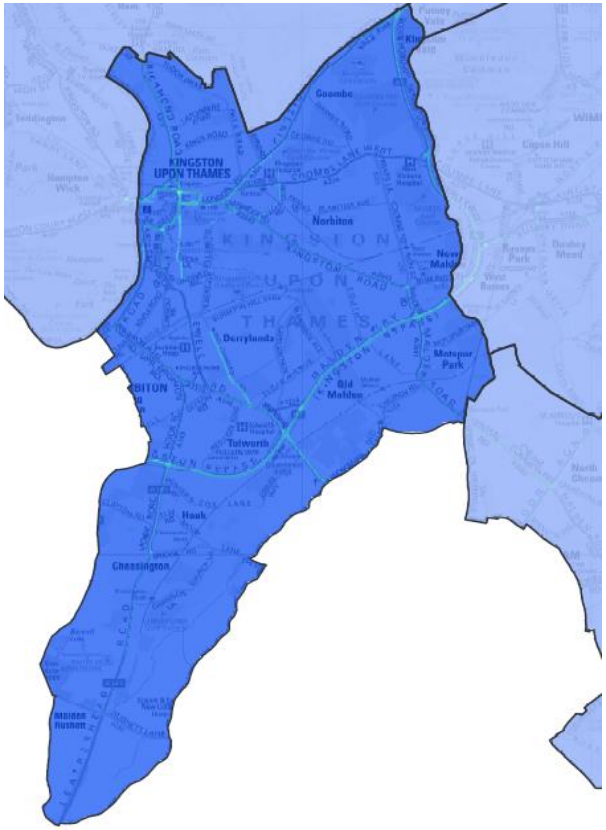
Figure B6: Annual Mean $PM_{2.5}$ concentrations for 2013 (baseline) & 2020 (projection)

2013

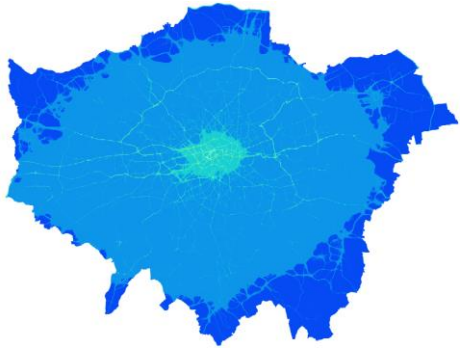




2020

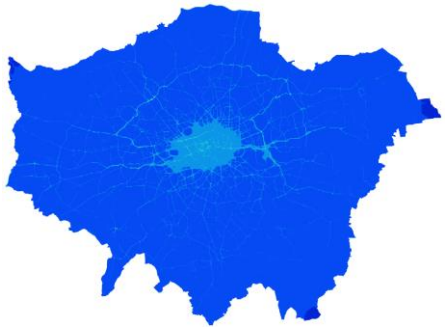


London inset



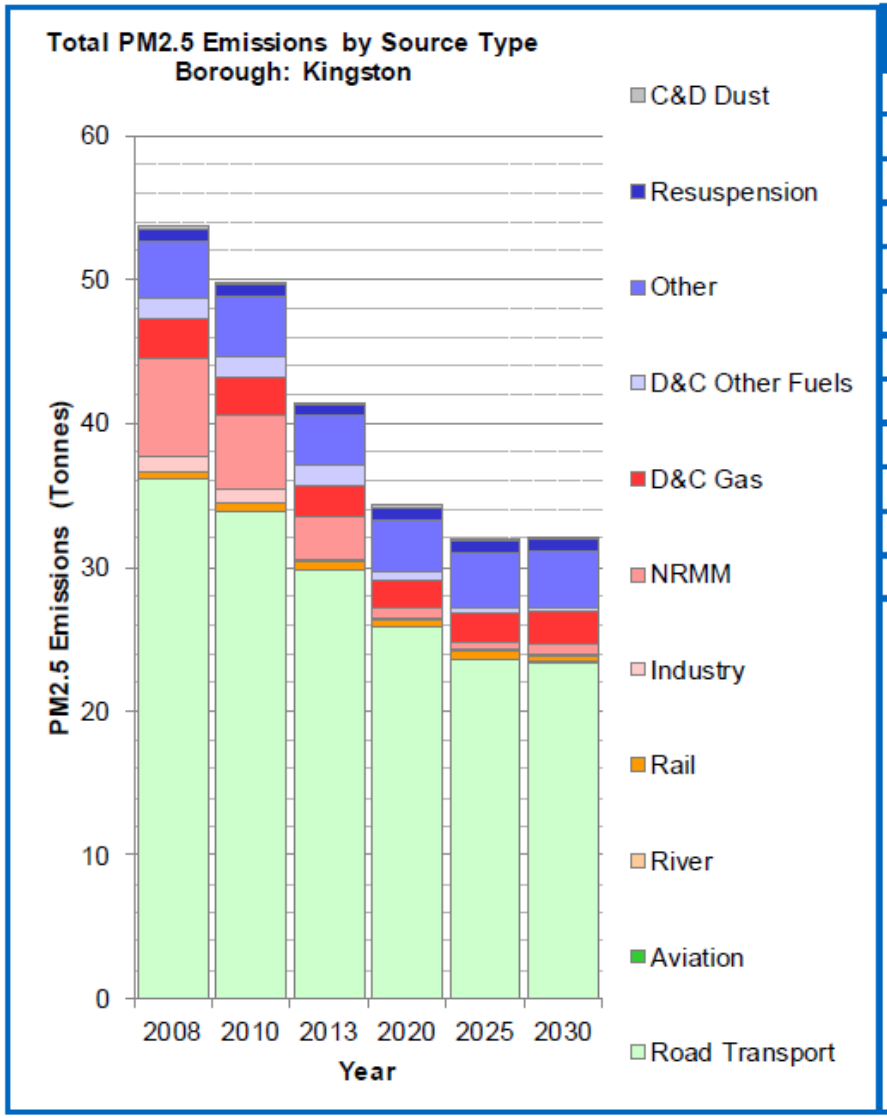
Source: Greater London Authority, 2017

London inset



$PM_{2.5}$ emissions for Kingston compare favourably against those present in London and surrounding boroughs. As with the previously presented emissions, there is a prediction that over future years the emissions will improve overall. As was shown in the PM_{10} predictions the greatest changes are predicted to be in road transport and non-mobile machinery. Contrary to PM_{10} predictions for resuspension of $PM_{2.5}$ emissions do not change.

Figure B7: LAEI PM2.5 emission dashboard for Kingston (2013 baseline and past and future projections)



Emissions (Tonnes) by	2008	2010	2013	2020	2025	2030
Road Transport	36.1	33.8	29.9	25.7	23.5	23.3
Aviation	0.0	0.0	0.0	0.0	0.0	0.0
River	0.0	0.0	0.0	0.0	0.0	0.0
Rail	0.5	0.5	0.5	0.5	0.5	0.5
Industry	1.0	1.0	0.1	0.1	0.1	0.1
NRMM	6.9	5.2	2.9	0.7	0.7	0.7
D&C Gas	2.8	2.6	2.3	2.0	2.0	2.1
D&C Other Fuels	1.4	1.5	1.3	0.6	0.3	0.3
Other	4.0	4.1	3.4	3.7	3.8	3.9
Resuspension	0.8	0.8	0.8	0.8	0.8	0.8
C&D Dust	0.1	0.1	0.1	0.0	0.0	0.0
Total	53.6	49.7	41.4	34.2	31.9	31.9

Notes:

(D&C = Domestic and Commercial – C&D = Construction and Demolition)

The summary graph represents emissions from each source stacked on top of one another, with the total stack height equalling the total emissions from all sources.

The numbers in the table are those used to plot the graph and represent the tonnes of pollution emitted into the atmosphere in that year (T/y).

The emissions are combined into reasonably self explanatory "Source Types".

However, the categories: "Industry", "NRMM" and "Other" require further explanation:

- **Industry:** is the total emission from Part A and Part B industrial processes, combined.
- **Non-Road Mobile Machinery (NRMM):** is the total emissions from construction and industrial off road machines, combined.
- **Other:** is the total emission from a number of small sources including: agriculture, outdoor fires, garden emissions, forests, waste and waste transfer sites, combined.

Source: Greater London Authority, 2017

Appendix C: Traffic, vehicle ownership and transport trends Kingston

Because the biggest source of air pollution in Kingston is road transport, changes in the way people use the road are likely to help explain changes in air quality. This section examines trends in vehicle ownership and road use in the borough.

Table C1 shows licensed vehicles statistics for Kingston and neighbouring boroughs. The total number of vehicle registrations in Kingston increased by 5% between 2009 and 2016. This was a slightly higher increase than for London as a whole (4%), but a smaller increase than for England (10%). However, the number of diesel cars and vans registered in the area has gone up much more quickly, rising by 57%, and increasing from just over a fifth (22%) of all vehicles to just under a third (32%).

Table C1: Licensed vehicles by body type, diesel cars and vans in Kingston and surrounding boroughs, London and England, 2009 and 2016 (thousands)

Region/ Local Authority	Cars	Motor cycles	Light goods	Heavy goods	Buses and coaches	Other vehicles	Total	Diesel Cars	Diesel Vans
2009									
England	24,028.5	1,116.2	2,714.1	411.1	144.2	473.8	28,887.8	6,440.1	2,537.8
London	2,556.7	125.3	215.5	20.6	19.7	30.2	2,968.0	457.7	194.4
Kingston	**63.4**	**3.4**	**5.3**	**0.2**	**0.2**	**0.5**	**73.0**	**10.9**	**4.8**
Sutton	81.8	4.1	7.3	0.6	0.2	0.8	94.8	12.0	6.6
Merton	69.5	3.6	5.8	0.6	1.9	0.7	82.2	12.6	5.2
Richmond	76.0	4.7	3.9	0.2	1.3	0.4	86.4	14.3	3.4
Wandsworth	83.6	7.3	5.5	0.4	0.5	0.4	97.8	16.4	4.8
Hounslow	91.0	4.0	7.7	1.6	0.6	1.0	105.8	17.9	6.8
Croydon	130.5	5.2	10.6	0.5	0.5	0.8	148.0	19.9	9.6
2016									
England	26,283.3	1,107.3	3,234.2	427.0	135.8	575.4	31,763.0	10,148.4	3,106.3
London	2,668.2	125.2	220.7	21.0	20.8	35.5	3,091.4	823.4	208.2
Kingston	**66.1**	**3.4**	**5.8**	**0.2**	**0.2**	**0.6**	**76.3**	**19.3**	**5.4**
Sutton	87.1	4.1	8.4	0.5	0.3	0.8	101.1	22.4	7.9
Merton	73.8	3.7	6.5	0.8	2.9	1.4	89.2	22.5	6.2
Richmond	77.5	4.3	3.9	0.2	1.1	0.5	87.5	23.9	3.5
Wandsworth	80.4	6.6	5.4	0.4	0.4	0.5	93.7	26.4	5.0
Hounslow	96.9	4.2	8.0	1.6	0.5	1.1	112.3	31.7	7.5
Croydon	140.8	5.4	11.8	0.6	0.3	0.8	159.8	38.0	11.2

Note:

1. *Vehicles are allocated to a local authority according to the postcode of the registered keeper. This is the keeper's address for privately owned vehicles or the company's*
2. *Includes rear diggers, lift trucks, rollers, ambulances, Hackney Carriages, three wheelers and agricultural vehicles*
3. *Refers to vehicles where the geographical location cannot be allocated due to the postcode being incomplete.*

Source: Vehicle Licensing Statistics (https://www.gov.uk/government/collections/vehicles-statistics), Department for Transport statistics

However, the number of vehicle registrations in the area does not take account of how vehicles are used, or of the number of vehicles coming into the borough from other areas. Table C2 is an examination of traffic flows in the borough since 1993, and also shows traffic flows in surrounding boroughs, London and England. It shows that vehicle kilometres travelled in Kingston have decreased over last two decades. Nevertheless,

the 2015 values are still much higher than some neighbouring outer London boroughs. Kingston includes major roads into London, which implies that a substantial proportion of traffic may be coming from elsewhere and that improving Kingston's air quality will also need coordinated action beyond the borough.

Table C2: Million Vehicle Kilometres travelled by all motor vehicles and all cars in Kingston and surrounding boroughs, London and England, 1993 to 2015

	Traffic Flows - Cars				Traffic Flows - All vehicles			
Local Authority	**1993**	**2003**	**2013**	**2015**	**1993**	**2003**	**2013**	**2015**
Merton	555	533	464	454	655	657	576	570
Sutton	600	591	498	502	697	715	605	614
Wandsworth	827	783	594	584	990	974	763	756
Richmond	764	742	641	634	884	892	772	776
Kingston	**852**	**828**	**736**	**724**	**983**	**988**	**890**	**888**
Croydon	1,129	1,094	935	936	1,321	1,333	1,152	1,162
Hounslow	1,364	1,373	1,241	1,223	1,591	1,641	1,506	1,498
London	25,560	25,661	22,752	22,841	30,712	31,946	28,819	29,231
England	291,498	335,391	330,879	341,499	355,306	418,481	418,255	436,281

Source: Department for Transport statistics

Appendix D: Methodological note on estimated deaths attributable to air pollution in Kingston

There are several ways by which the impact of air pollution upon health could be measured. COMEAP (the Committee on the Medical Effects of Air Pollution, a UK government advisory body) has released a guidance statement in 2010 on how local estimates of the mortality burden of long term exposure to particulate air pollution at the local level can be reached. The three indicators recommended by COMEAP are:

- Attributable fraction, the proportion of the local mortality burden (in terms of deaths) attributable to exposure
- Attributable deaths, a calculation of the number of actual deaths attributable to exposure
- Years of life lost, focussing upon the number of attributable deaths and the age at which these occur to determine the loss of life associated with exposure

To note, the attributable deaths statistic is an estimate of the overall health effect of air pollution on the population of an area. It is derived from the rise in risk of death associated with a standard level of pollution, then converted to an equivalent number of deaths based on population and pollution levels to help describe the scale of this risk.

The recent Public Health England report 'Estimating Local Mortality Burdens associated with Particulate Air Pollution, (2014) which focussed on sources of anthropogenic or man-made $PM_{2.5}$, highlighted the numbers of attributable deaths in people aged 25 and over. In England this figure was suggested to be 25,002 deaths per year attributable to $PM_{2.5}$ alone, with 264,749 life years lost and UK was nearly 29,000 deaths associated with anthropogenic $PM_{2.5}$. This translates for Kingston as potentially 68 premature deaths or 730 life years lost due to $PM_{2.5}$ alone[81].

DEFRA, UK, creates an annual all-cause adult mortality attributable fraction to anthropogenic particulate air pollution (measured as fine particulate matter, $PM_{2.5}$) based on a 1km x 1km grid using an air dispersion model. This indicator is included in the Public Health Outcomes Framework (PHOF) and local authorities are expected to monitor this and show progress on (Table Nine). An increase of 10 $\mu g/m^3$ in population-weighted annual average background concentration of $PM_{2.5}$ is assumed to increase all-cause mortality rates by a unit relative risk (RR) factor of 1.06. Table 8 illustrates the fraction of all-cause adult mortality attributable to anthropogenic particulate air pollution in Kingston, London and England.

Using latest data in the Public Health Outcomes Framework (Table D1) we see that the fraction of deaths attributable to particulate air pollution in Kingston is estimated to be 6.7% in 2010 and 2011. However, there has been a noticeable decrease in these fractions gradually by 2015 reducing to 5.1%, which was still higher than the national (5.1%) average, but below the regional (5.6%).

Table D1: Estimated effects on annual mortality in 2010 of anthropogenic $PM_{2.5}$ air pollution in Kingston, London and England

	Mean Anthropogenic $PM_{2.5}$	Attributable fraction (%)	Attributable deaths (aged 25+)	Associated life years lost
Kingston	11.9	6.7	68	730
London	12.7	7.2	3,389	41,404
England	9.9	5.6	25,002	2,64,749

[81] https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution

Source: Estimating local mortality burdens associated with particulate air pollution, Public Health England

Table D2: Fraction of all-cause adult mortality (persons aged 30 years and above) attributable to anthropogenic particulate air pollution (measured as fine particulate matter, PM2.5) in Kingston, London and England, 2010 to 2015

Period	Kingston	London	England
2011	6.7	7.2	5.4
2012	6.1	6.6	5.1
2013	6.2	6.7	5.3
2014	5.9	6.5	5.1
2015	5.1	5.6	4.7

Note: $PM_{2.5}$ means the mass (in micrograms) per cubic metre of air of individual particles with an aerodynamic diameter generally less than 2.5 micrometers. $PM_{2.5}$ is also known as fine particulate matter

Source: Public Health England, 2017

The research carried out by the Institute of Medicine (IOM)[82] also estimates the mortality impacts of $PM_{2.5}$ in London. The IOM research determined that in 2008, 91 deaths were attributable to $PM_{2.5}$ in Kingston. The data from the IOM research and the Public Health Outcomes Framework differ to some extent due to the methodologies used. The Department of Health methodology used for the Public Health Outcomes Framework weights background concentrations (for a 1km x 1km grid) of $PM_{2.5}$ by local authority population size. The methodology makes the assumption that every 10µg/m^3 of population-weighted annual average background concentration of $PM_{2.5}$ carries an annual relative death risk of 1.06. This means that for every 10µg/m3 of $PM_{2.5}$ in the atmosphere, there will be 6% more deaths each year than there would be without that 10µg/m3 of $PM_{2.5}$ present. The IOM research follows a similar methodology however it used a London specific model which gives a finer resolution compared to the national model used for the PHOF. This, combined with other changes in other assumptions, accounts for the variation between the two datasets.

Table D3, below, provides a breakdown of the number of deaths attributable in each of the wards in the borough based on population size, total number of deaths in Kingston and fraction of all-cause adult mortality (persons aged 30 years and above) attributable to anthropogenic particulate air pollution (measured as fine particulate matter, PM2.5). To note, “Attributable Deaths” do not represent a subset of all deaths that are solely caused by $PM_{2.5,}$ many will have other unrelated respiratory issues that are impacted by pollution in the air. Everyone living in the London Borough of Kingston breathes the air and their health is impacted, when the risk to all the individuals is combined it is equivalent to this “attributable” number of deaths. To also note, this data is based on resident population (and therefore does not include for example the impact of exposure to $PM_{2.5}$ on non-residents who work, study, visit or “move-through” the borough, or the larger population registered with a Kingston GP).

[82] www.iom.edu/

Table D3: Number of deaths attributed to exposure to $PM_{2.5}$ pollution in 2008 in wards in Kingston

Ward	Total Population	Annual deaths attributable to PM2.5
Alexandra	9,176	5
Berrylands	9,582	6
Beverley	10,063	6
Canbury	11,308	7
Chessington North and Hook	8,825	5
Chessington South	10,023	6
Coombe Hill	10,361	6
Coombe Vale	9,453	6
Grove	9,152	5
Norbiton	9,569	6
Old Malden	9,194	5
St.James	8,758	5
St.Marks	9,822	6
Surbiton Hill	10,627	6
Tolworth and Hook Rise	9,703	6
Tudor	8,589	5

Source: Institute of Medicine (IOM), 2010 Accessible via 'Air Quality Information for Public Health Professionals – London Borough of Kingston upon Thames' report from Greater London Authority

Appendix E: Glossary

Air Quality Monitors are devices for measuring the level of pollution in an area.

Air Quality Objectives are targets for improvements in air quality which are set out by the UK and EU. They are listed in Table 4.

Asthma is a long-term lung condition which is usually controllable. Symptoms of uncontrolled asthma include shortness of breath, coughing and tightness in the chest.

Attributable deaths refers to the proportion or number of deaths in a population which can be attributed to a particular cause (in this case, air pollution).

Benzene is a chemical found in petrol

Cardiovascular disease refers to all conditions of the heart and circulatory system, including coronary heart disease and stroke.

Chronic disease refers to any long-term condition

COPD stands for Chronic Obstructive Pulmonary Disease, a lung condition which causes breathing difficulties which can't always be reversed with treatment.

DEFRA is the UK Government's Department for Environment, Food and Rural Affairs

Emissions are substances which are discharged from a process

Index of Multiple Deprivation is used as a way of measuring and comparing different kinds of deprivation between small areas. It was created by the UK government.

Limit values are air quality targets set by the EU, which are translated into UK air quality objectives.

NO_2 and NO_x are oxides of nitrogen, gases produced when fuels are burned at high temperatures

Non-Road Mobile Machinery (NRMM) is any mobile machine, item of transportable industrial equipment, or vehicle which isn't intended for transport of passengers or goods but has a combustion engine (eg generators or bulldozers(

Particulate matter (also referred to as particulates, PM_{10} and $PM_{2.5}$) is a mixture of tiny particles made up of different chemicals. It's categorised by the size of the particles rather than by what they are made from. PM_{10} means particles that are less than 10 microns across, while $PM_{2.5}$ means particles less than 2.5 microns across.

Pollutants are substances introduced to the environment that have harmful effects

Respiratory infections are infections of the sinuses, throat, airways or lungs and are usually caused by viruses. The common cold is the most widespread but some respiratory infections can be more serious.

Sulphur dioxide or SO_2 is a gas which comes from burning fuels.

Socioeconomic gradient refers to a relationship between socioeconomic status and other outcomes. The socioeconomic gradient in health means that on the whole, the more wealth someone has, the more likely they are to be healthy.

Stroke is a serious medical condition which arises when blood supply to part of the brain is cut off

Zero-emission travel zero emission vehicles release no emissions from their main source of power